DEPARTMENT OF AGRICULTURAL DEVELOPMENT

ADMINISTRATION: HOUSE OF ASSEMBLY

CAB INTERNATIONAL
MYCOLOGICAL INSTITUTE
LIBRARY
26 JUN 1991
ST 32/S

ANNUAL REPORT

1 April 1989 to 31 March 1990

REPUBLIC OF SOUTH AFRICA

ANNUAL REPORT

of the

Superintendent-General of the Department of:
Agricultural Development
for the period
1 April 1989 to 31 March 1990

Published by Authority

Selling price
(GST excluded)
Local **R7,80**
Other countries **R9,75**
Post free

RP 43/1991

Published by the Department of Agricultural Development and obtainable from the Directorate of Agricultural Information, Private Bag X144, Pretoria 0001

Printed by Cape & Transvaal Printers (Pty) Ltd, Cape Town, for the Government Printer, Pretoria, Tel (012) 323-9731 X267—BB5911/1 200

1991

ISBN 0 621 13458 9

Report of the Superintendent-General of the Department of Agricultural Development for the period 1 April 1989 to 31 March 1990

THE HONOURABLE THE MINISTER OF AGRICULTURAL DEVELOPMENT,
PRETORIA

Sir,

I have the honour to submit herewith the Annual Report of the Department.

Dr F.J. van der Merwe
Superintendent-General of the Department of Agricultural Development

CONTENTS

	Page
INTRODUCTION	1
ORGANISATION AND FUNCTIONS OF THE DEPARTMENT	5
Executive directorate	5
EXPENDITURE	9
PLANT PRODUCTION PROMOTION	11
Agronomy research	11
Summergrain	11
Small grain	11
Oil and protein seeds	13
Other crops	14
Horticultural research	15
Pome, stone and other fruit	15
Viticulture and oenology	18
Citrus and subtropical crops	22
Other subtropical crops	25
Vegetables and ornamental plants	25
Plant protection research	27
Entomology	27
Plant pathology	29
Weed research	30
Plant biotechnological research	32
ANIMAL PRODUCTION PROMOTION	34
Production research	34
Animal breeding and genetics	34
Nutrition	35
Animal physiology and meat science	39
Dairy science	40
Poultry science	40
Performance and progeny testing	41
Veterinary research	42
Vaccine production and development	42
Viral diseases	42
Foot-and-mouth disease	43
Protozoal diseases	44
Bacterial and reproductive diseases	44
Entomology	45
Toxicology	46
Food and milk hygiene	46
Information management	46
AGRICULTURAL RESOURCE DEVELOPMENT	47
Resource research	47
Regional development	48
DEVELOPMENT OF ENTREPRENEURS	53
Programmed extension	53
Training	56
Agricultural information services	56
Agricultural engineering services	58
PASTURE RESEARCH	61
Veld research	61
Cultivated pasture	62
AGRICULTURAL FINANCE	65
AGRICULTURAL ECONOMICS	69
SUPPORTING SERVICES	70

INTRODUCTION

The annual report, and therefore this introduction, must take the reader back to the period from 1 April 1989 to 31 March 1990. This was the last year of the decade of the 1980s which, from 1982, embraced one of the longest and most devastating drought cycles in the history of the extensive grazing areas and the summer rainfall cropping areas. This was followed by floods leaving extensive destruction in their wake in 1987 and 1988.

The dramatic way in which the natural environmental factors and national economic factors illustrated to one and all how sensitive the balance is between the natural resources, production and marketing decisions and agricultural economics, caused many people to take a closer look at agriculture and to develop greater understanding for the industry.

The situation reaffirmed the realisation that the welfare of agriculture not only affects the farmer, the rural areas, the input suppliers and secondary industries, but that it is also a prerequisite for acceptable economic, social and political order and for stability in the community in general.

In South Africa government involvement in agriculture concerns firstly the ongoing supply of adequate and essential food to the inhabitants of the country - a function for which, in the final analysis, the government accepts responsibility. It also concerns the protection of the country's natural agricultural resources and the economic and financial stabilisation of the agricultural community in the midst of exceptional variables, both in respect of production and marketing. In part government involvement also concerns the social and area-stabilising dimension of agriculture; especially insofar as it promotes the occupation and development of the extensive rural areas and the stabilisation of rural communities.

Progress with the revision of the service structure

Government involvement in agriculture via the Department of Agricultural Development in the Administration of the House of Assembly is aimed at research, extension, training at colleges of agriculture, soil conservation, water supply and financial assistance to farmers. For the implementation of these functions, the Department has available an extensive infrastructure and a competent personnel corps who are attuned to:

- the generation of applicable agricultural technology by way of research and development
- persuasion of a maximum number of farmers, by means of extension, to implement agricultural practices that are aimed at and will promote profitable farming and optimum resource use
- equipping a maximum number of farmers to meet the demands of present and future agriculture by means of training
- supporting a maximum number of farmers to achieve economic independence by means of financial assistance from the state coffers.

The extensive infrastructure with research institutes, colleges of agriculture and service points throughout the country, is a national asset of incalculable value. Over the past 2 years a critical evaluation was made of the service structure to identify constraints on effective service and to adapt the service, where neccessary, to changed circumstances. In the process in-depth consultations were held with Organised Agriculture, the co-operatives, the private sector and the universities. This led the Cabinet to decide, on the recommendation of the Ministers' Council of the House of Assembly, to convert the research arm of the Department into a statutory agricultural research council (ARC).

The large number of institutions and persons consulted were overwhelmingly in favour of the foundation of an autonomous agricultural research council which could take its place next to the existing scientific councils. The only concern was that research and extension should not be separated, but should remain under the same authority. Although this would naturally be the ideal state of affairs, the process of separation is already irreversible. In South Africa agricultural research and extension have for some time not been under the same roof. Evidence of this is the more than 1 000 agricultural scientists employed by co-operatives, control boards, commodity organisations and private institutions, all of which provide the farmer with technical extension and advice.

The establishment of an agricultural research council, as envisaged, will mean that the Department's present personnel core and its operational budget will be considerably reduced. According to the present policy of a smaller, more efficient Public Service, this would offer the opportunity for restructuring the Department's extension, training and advisory capacity to the farming communities which it has to serve country-wide.

For the recovery and further expansion of a financially more sound and independent farming community, it is essential that training, extension and advisory services be undertaken and executed in a co-ordinated manner.

One of the main motivations for the then CISA investigation was the drain of extension officers from the Department to the co-operatives and other private institutions and the resultant inability to

provide effective, co-ordinated services. In the meantime the Department and the SAAU, with the full support of the co-operatives, agricultural input suppliers and agricultural marketing boards, launched a Co-ordinated Extension campaign in the summer rainfall cropping area. Although it was difficult to get all the institutions together and keep them so, the success achieved with Co-ordinated Extension has already made a major contribution towards a more efficient service and less overlapping in the summer rainfall cropping area.

From lessons learnt over the past few years, it became apparent that the Department has a key role to play - one without which the South African farmer cannot manage - in the development of technology (adapted cultivars, livestock improvement techniques, etc.), and the objective dissemination of this knowledge. The Department cannot, however, cope with transfer and implementation on its own. It must, as in the case of the present Co-ordinated Extension campaign, work in close collaboration with its partners, which include the SAAU.

To have the necessary expertise available as close as possible to the farmer, and to promote efficient technology transfer from a total-farm/total-enterprise approach, the Department envisages the establishment of a number of Agricultural Development Centres (ADC) within the present agricultural development regions.

Such an ADC will accommodate a multi-disciplinary team of agricultural commodity and specialist officers to support the departmental extension officers and those of the co-operatives with specialised econometric, agronomic, animal science, horticultural, pasture and fertilisation know-how. In reality the establishment of ADCs in subregions will be an extension of the present regional service structure where the specialists in the various disciplines are concentrated at the regional headquarters such as Elsenburg, Glen, Cedara, Potchefstroom, etc. As already mentioned, it will bring the expertise closer to the farmer on his farm and closer to the extension officer in his ward or the service area of his co-operative. The ADC will be a channel of communication between the researchers on the one hand and the farmer and his advisers on the other hand. All ADCs will be established on existing experimental farms so that farming systems and relevant technology can be tested and demonstrated there.

The economist and the economic analysis of farming enterprises and agricultural industries as points of departure for effective advice and extension, will play an important role in the future service structure. The ADC will be equipped in such a way that it, apart from the personal expertise of the agriculturists, will also make available to farmers the data stored by the computer. The specialists at the ADC will maintain close contact with researchers and will constantly be involved with the further development of research data and the testing and adapting of technology to local conditions. They will concentrate especially on systems analyses and the creation of economically sound practices. In the whole process they will keep in close touch with co-operatives and marketing boards. In this regard the Area Committees of the present Co-ordinated Extension campaign could play an important role.

Agricultural conditions during the year under review

In the summer rainfall cropping area the year under review started off with very favourable weather conditions. Excellent rains occurred from the start of the rainy season in October 1988. These favourable conditions continued throughout the growing season and resulted in a large maize crop of 11,2 million t being harvested - one only surpassed by that of 1981 when 14,4 million t were harvested. Smaller plantings of grain sorghum, sunflower and groundnuts resulted in slightly smaller crops of these commodities than in the previous year.

Winter grain plantings also benefited from the good rains that occurred during the first 4 months of the year which resulted in a generally high soil moisture. There was a decline of about 8 % in wheat plantings. The smaller wheat plantings in the Western and Southern Cape led to increased oats, rye and barley plantings.

Poorer agricultural conditions during the second half of the season dealt a severe blow to the wheat crop, especially in the Free State, Transvaal and Rûens. A disappointing crop of just over 2 million t was harvested compared with the record 3,5-million-t crop of the previous year. Poor agricultural conditions also had a negative effect on oats, barley and rye yields.

The favourable weather conditions in the summer rainfall areas during the 1988/89 growing season were also reflected in the livestock industry. Stock drinking water, veld grazing and crop residues were generally plentiful and the livestock in a good condition. Drought conditions only occurred in parts of the Eastern Cape and Northern Transvaal, but good rains towards the end of 1989 again brought relief, so that by the end of the year only 10 districts or portions thereof were still on the emergency grazing list - three in the Transvaal and seven in the Cape Province. The previous year 13 districts and portions of districts, all in the Cape Province, were on the emergency list. Most of the districts removed from the emergency list during this year, were situated in the Northern Cape.

Progress with continued financial and technical assistance to farmers after disaster floods

Only in the year now under review is it possible to report on the Department of Agricultural Development's exceptional role in giving financial assistance to the value of R80 million to farmers devastated by disaster floods.

Over the past 10 years the Department administered extensive financial assistance measures

for farmers who suffered damage in four major flood disasters. The Department gained valuable experience during this time - experience that could be of great benefit in future floods.

The serious floods that hit the Natal Region, the OFS Region and the northern part of the Karoo Region along the Orange River during the past 2 years, meant that the Department had to provide emergency assistance in various fields at short notice. Extensive flood damage to soil conservation and irrigation works and property occurred and hundreds of dams, canals and irrigation systems were literally destroyed.

The two most recent flood disasters (September/October 1987 in Natal and February/March 1988 in all four provinces) affected 1 571 and 2 665 farmers respectively. This meant that the various agricultural credit committees and the Directorate of Financial Assistance had to deal with more than 10 000 claims, which demanded substantial inputs from the magistrates, agricultural credit committee members and officials. To facilitate the committees' tasks, special additional personnel were appointed and some of the committees were augmented by as many as 12 members. The assistance of expert national servicemen from the SA Defence Force was also obtained to assist with the professional work such as surveying dams and other engineering services. To assist with the extensive and urgent tasks, all available personnel such as industry technicians, extension officers, engineers and economists were mobilised. Technical assistance of a comprehensive nature was rendered throughout.

The Directors of the regions concerned, the Directorate of Soil Conservation and Drilling Services and the Directorate of Irrigation Engineering mobilised emergency planning teams to make preliminary and, later, final surveys of damage. Schemes for various categories of flood damage had to be devised and approval obtained for compensation. During such an emergency disaster a number of institutions are involved, such as State departments, the SA Defence Force, local authorities and service organisations such as agricultural co-operatives and farmers' associations. Constant co-ordination at all levels was therefore essential to prevent confusion and overlapping. For this reason the Directors of the Natal and OFS Regions served on the Technical Disaster Flood Subcommittee which had to advise the Cabinet Committee on the nature and extent of flood damage and payments to farmers. The Head of the Department was co-opted to the Cabinet Committee.

The Department succeeded in handling this comprehensive additional work load without any noteworthy delay. Most of the claims were controlled and paid within 4 weeks after submission to agricultural credit committees. For various reasons, including the extent of the flood damage to soil conservation works and the formation of pans with the resultant large areas that could still be under water for several years, farmers could not complete all the flood-damaged soil conservation works within the 30 months that would normally apply in the case of the Flood Assistance Scheme for Disaster Flood Areas. Farmers were assisted. Firstly, the period for which the Flood Assistance Scheme would apply was extended by 18 months. Secondly, provision was made that where fences were submerged, farmers could qualify for subsidies for the repair or reconstruction of such fences until 31 December 1999.

The experience which the Department gained with these unexpected and extensive flood disasters enabled management to compile a flood assistance plan that can be used for similar disasters in future. This plan makes provision for a systematic classification of the required emergency actions and follow-up procedures that must be carried out. In this way it will in future be possible to grant State assistance to farming communities that suffer such crises, even more promptly and efficiently.

Progress with structural adjustments in farming

A scheme for the conversion to pasture crops of land that is not suitable for long-term profitable crop production, was introduced in October 1987. The scheme that will continue until 1995/96, is aimed at relieving livestock pressure - caused by overgrazing - on natural veld grazing, and to increase the profitability of summer grain production. The target is 1 million ha converted land.

Up to the end of the year under review (March 1990), 4 711 applications for the conversion of 461 558 ha were received. Of this 160 181 ha have already been successfully established and a total amount of R20 million had been paid in establishment subsidies and bridging financing during the year under review. The target to the end of March 1990 was 450 000 ha.

Following representations by Organised Agriculture, upward adjustments were made to the tariffs during the year under review, and provision was also made for the payment of an advance establishment payment. In co-operation with Organised Agriculture, evaluation actions were launched at the end of the year under review. The increased tariffs had a positive effect on the application rate, but there are indications that, in spite of this upswing, it is unlikely that the 1-million-ha target will be reached within the period up to 1992/93. This is naturally a scheme that could yield only long-term economic benefits for the individual farmer. Under prevailing economic conditions and the poor financial position in which the successive droughts and deteriorating terms of trade had placed farmers, the sacrifices that have to be made in the shorter term in the interest of the structural adjustment, are probably too much for many farmers.

Following an investigation into the position of wheat farmers in the Western and Southern Cape, special assistance measures were introduced for those farmers. These consist of a carry-over debt scheme with subsidised interest rates, a debt consolidation programme by the Land Bank and a land conversion

scheme with a view to creating a more diversified, less risky farming system. Interest in the conversion scheme during the first full season did not quite come up to expectations. Once again this probably reflects the fact that conversion to livestock does not offer short-term financial solutions, although it is the right long-term step in the direction of a more balanced farming system.

Progress in technology transfer

The Department is thoroughly aware of the necessity that scientific data obtained from research and other products of long-term research such as improved cultivars, improved vaccines, improved tillage techniques, etc., must be implemented so that farming profit can be increased and optimum resource use can be supported and promoted.

Intensive analyses by the Department's Directorate: Agricultural Economics of the economic and financial position of farmers in the different areas, reveal striking differences in farmers' efficiency levels when measured against profit margins. This is irrespective of the type of enterprise and the influence of external climatic and economic/financial factors.

The following are a few examples of gaps between the best one-third and the worst one-third entrepreneurs' results in terms of net farming income per R100 capital invested.

Type of enterprise and area	Year	Norm	Best third R	Worst third R
Intensive grape farming - Hex River Valley	1989	NFI/R100 Gross margin/ha (table grapes)	38,91 36 001	10,81 19 191
Mixed cropping - E. and S-E. OFS	1989	NFI/R100 Gross margin/ha (wheat)	17,55 655	10,14 280
Extensive small-stock farming - Karoo	1989	NFI/R100 Gross margin/SSU (fine-wool-led sheep)	10,37 107,70	8,39 65,19

The data show that, despite the relatively high input costs and deteriorating terms of trade in agriculture, there is much room for improvement in efficiency levels and that this can be addressed by extension. It is also clear that when extension is aimed more at management aspects and record-keeping, improved technology is more readily applied.

In two specific farming areas, namely the Vaalharts irrigation scheme and the Ohrigstad Valley, a start was made during the year under review with locally directed co-ordinated extension actions. In each case the director of the agricultural development region concerned, that is the OFS Region in the case of Vaalharts and the Transvaal Region in the case of Ohrigstad, took the lead with the planning and co-ordination of actions in which a number of role players, including research institutes, co-operatives, a university and the National Productivity Institute (NPI), were involved.

In each case the launching of the extension and technology transfer programmes followed on in-depth economic and financial investigations. In the case of Ohrigstad, the programme included direct financial aid to farmers. Both actions are still in progress.

Progress with research and foreign liaison

This report comments in full on progress with ongoing research and other technical actions. It is clear that the Department's scientists are involved with priority research over a wide spectrum.

With a view to the constant refinement and improvement of research techniques and the broadening of insight, departmental researchers keep in close contact with local university lecturers and post-graduate students and with researchers abroad by attending congresses and study tours. A number of authoritative foreign scientists worked as research fellows at departmental institutes for shorter or longer periods and made important contributions towards technology development and the solution of local production problems.

Despite the cold winds of isolation, the departmental scientists succeeded in maintaining good contacts and even extending these in some cases. In support of contacts that resulted from scientists' personal achievements, the RSA's agricultural representatives abroad also again succeeded in making new contacts and putting young researchers in the RSA in touch with their peers abroad.

ORGANISATION AND FUNCTIONS OF THE DEPARTMENT

The Department of Agricultural Development has the responsibility of promoting optimum agricultural production and the welfare of the farmers in the White population group of the RSA. According to the Constitution the Department is specifically responsible for the following services and assistance measures:

- Agricultural development services, including research, advisory services and extension
- Training at colleges of agriculture
- Financial and other assistance to farmers or prospective farmers or for the promotion of agriculture
- Irrigation schemes
- Drilling for water for agricultural and local authority purposes
- Subsidising of drilling and water affairs for agricultural and local authority purposes
- Financial assistance in respect of water-works damaged by floods.

To accomplish these tasks the Department consists of an Executive Directorate with the Superintendent-General assisted by an Executive Director and six chief directors who are responsible for the management functions of the Department. At the level of implementation, 24 institutions, each with a Director in charge, are responsible for the specialised functions.

EXECUTIVE DIRECTORATE

Agriculture Building, Beatrix Street, Private Bag X116, Pretoria 0001

Dr F.J. van der Merwe: Superintendent-General
Vacant: Executive Director

Chief Directorate

Agronomy

Vacant: Chief Director
Vacant: Senior Agricultural Management Adviser

Horticulture

Dr G.S. Bredell: Chief Director
Dr J.L. van Zyl: Senior Agricultural Management Adviser

Agricultural Engineering and Water Supply

Mr J.J. Bruwer: Managing Engineer
Vacant: Agricultural Management Adviser (Irrigation)

Animal Production

Dr R.D. Bigalke: Chief Director
Dr J.A. Erasmus: Agricultural Management Adviser

Farming Development

Dr H.S. Hofmeyr: Chief Director
Dr C.H. de Klerk: Senior Agricultural Management Adviser (Extension and Training)
Vacant: Senior Agricultural Management Adviser (Natural Resources)

Auxiliary Services

Mr H.F. van Zyl: Chief Director

Specialised Research Institutions

Animal and Dairy Science Research Institute
Private Bag X2, Irene 1675

Dr R.T. Naudé: Director
Dr J.J. du Toit: Deputy Director
Dr P.E. Lombard: Deputy Director
Vacant: Deputy Director
Dr E.H. Kemm: Deputy Director

The Institute, at various centres throughout the country, undertakes performance and progeny testing at the national level, as well as fundamental research on the breeding, feeding and physiology of farm animals. The Institute is also responsible for dairy and poultry research on a country-wide basis as well as for the training of dairy technologists at Glen.

Citrus and Subtropical Fruit Research Institute
Private Bag X11208, Nelspruit 1200

Dr J.H. Terblanche: Director
Dr A.J. Joubert: Deputy Director

The Institute is responsible for country-wide research on all aspects of the citrus and subtropical fruit industry, as well as nuts, tea, coffee and herbs.

Fruit and Fruit Technology Research Institute
Private Bag X5013, Stellenbosch 7600

Dr P.C. van Rooyen: Director
Dr H.J. van Zyl: Deputy Director

The Institute is responsible for country-wide research on deciduous fruit and other minor industries such as olives, almonds, kiwi fruit, dates, berries, prickly pear and hops. Research is also done on fruit technological aspects of subtropical fruit and certain vegetable crops.

Grain Crops Research Institute
Private Bag X1251, Potchefstroom 2520

Dr J. de Kock: Director
Dr J. le Roux: Deputy Director (Winter Grain)
Dr K.W. Pakendorf: Deputy Director (Oil and Protein Seeds)
Dr J. Dreyer: Deputy Director (Summer Grain)

The Institute is responsible for research on the improvement and cultivation of summer and winter cereals and high protein seeds and oilseeds.

Plant Protection Research Institute
Agriculture Building, Beatrix Street, Private Bag X134, Pretoria 0001

Dr I.H. Wiese: Director
Dr D.P. Keetch: Deputy Director
Dr V.D. Wassermann: Deputy Director
Dr J.C. Staphorst: Deputy Director

The Institute is mainly responsible for advanced research at the national level on plant pathology, insect and animal pests and their control. This includes microbiology, taxonomy of fungi, identification of virus diseases, the freeing of propagation material from viruses, honey-bees, insects in stored grain, forest and timber insects, taxonomy of insects and nematodes, economic zoology, toxicology of insecticides and the biological control of insect pests and weeds. The Institute is also responsible for the examination and control of imported plant material and the control of migratory locusts.

Soil and Irrigation Research Institute
600 Belvedere Street, Arcadia, Private Bag X79, Pretoria 0001

Dr D.M. Scotney: Director
Mr T.E. Döhse: Deputy Director
Dr J.F. Eloff: Deputy Director
Dr A.J. van der Merwe: Deputy Director
Vacant: Deputy Director

The Institute is responsible for the classification of the resources soil and climate of the Republic as well as basic research to promote the efficient utilisation of soil, water and fertilisers, to identify problems in this regard and to find answers to these problems with a view to the improvement of agricultural production and the protection of the resources soil and water. Soil surveys for irrigation projects and investigations into physical soil properties are also undertaken - particularly where brack and waterlogging conditions occur. In addition, the Institute is responsible for basic irrigation research and the agricultural evaluation and planning of irrigation areas. All agricultural meteorological research and data collection also fall under this Institute and the remote sensing component acts as the specialist centre of the Department. The Institute undertakes the chemical analysis of soils, water and plant material, not only for this Department but also for other State Departments, Provincial Administrations and other bodies. It is also responsible for the inspection and analysis of fertilisers, stockfeeds, stock remedies and agricultural remedies in terms of Act No. 36 of 1947.

Tobacco and Cotton Research Institute
Private Bag X82075, Rustenburg 0300

Dr B.W. Strydom: Director
Dr G.D. Joubert: Deputy Director

The Institute is responsible for research, including technological research, in the interest of the cotton and the tobacco industry in all parts of the country.

Vegetable and Ornamental Plant Research Institute
Private Bag X293, Pretoria 0001

Dr J.T. Meynhardt: Director
Dr W.P. Burger: Deputy Director

The Institute is responsible for all applied and fundamental research and specialised extension on vegetables, cut-flowers, ornamental plants and shrubs throughout South Africa. The Institute controls vegetable, flower and ornamental plant research at Roodeplaat in the Transvaal Middleveld and cherry research at Emperani, near Ficksburg.

Veterinary Research Institute
P.O. Onderstepoort, Pretoria 0110

Dr D.W. Verwoerd: Director
Dr J.D. Bezuidenhout: Deputy Director
Dr F.T. Potgieter: Deputy Director
Dr B.J. Erasmus: Deputy Director
Dr G.R. Thomson: Deputy Director

The Institute is concerned with research on diseases of stock and game (infectious and others, including diseases caused by malnutrition), diagnostics, the preparation of vaccines and diagnostic aids, and the biological evaluation of dips and remedies submitted for registration.

Viticultural and Oenological Research Institute
Private Bag X5026, Stellenbosch 7600

Dr J. Deist: Director
Mr C. Kok: Deputy Director

The Institute is responsible for all research in the sphere of viticulture and oenology, *inter alia*, viticultural research in the Lower Orange River area.

Grassland Research Centre
Private Bag X05, Lynn East, Pretoria 0039

Dr A.J. Aucamp: Deputy Director (Head)

The Centre is responsible for research concerning veld and cultivated pastures. The functions include, among others, the collection, introduction and evaluation and the breeding and selection of pasture and fodder crops with a view to increased production and nutritional value. Information is also gathered on stress factors, physiological processes and optimum cultural and utilisation practices.

Plant Biotechnology Research Centre
Private Bag X293, Pretoria 0001

Dr D.I. Ferreira: Deputy Director (Head)

The Centre is responsible for advanced plant biotechnological research to support the Department's crop-breeding programmes. Activities include mainly cell biological and molecular biological approaches to plant breeding and link up directly with breeding programmes launched by Departmental institutions.

Directorates

Agricultural Economics
Private Bag X416, Pretoria 0001

Mr B.J. van Wyk: Director
Mr G.R. Backeberg: Deputy Director

The Directorate's main task is to research the production economics of agriculture and to make known the research results and general production economics principles.

Agricultural Information
Agriculture Building, Beatrix Street
Private Bag X144, Pretoria 0001

Dr R.J. van Niekerk: Director
Mr L.L. Lötter: Deputy Director
Vacant: Deputy Director

The functions of the Directorate are to support research and extension within the Department by means of scientific publications, library and data-documentation services and to promote agricultural development via the mass media such as the radio, television and popular scientific publications.

Agricultural Mechanisation
Private Bag X515, Silverton 0127

Mr A.J. Heyns: Chief Engineer
Mr P.A. Henning: Deputy Chief Engineer
Mr P.J. Britz: Deputy Chief Engineer
Mr J. Fuls: Deputy Chief Engineer

As one of the constituents within the Chief Directorate Agricultural Engineering and Water Supply, this Directorate conducts research, development, test work and technology transfer in the fields of agricultural machinery, mechanisation planning, agricultural structures, farm buildings, animal housing and agricultural energy.

Agricultural Technical Administration
Agriculture Building, Beatrix Street, Private Bag X116, Pretoria 0001

Vacant: Director
Mr S.O. Joubert: Deputy Director

Administrative support to management. Manages also specific matters regarding foreign study tours, research fellows, foreign visitors, international organisations of which the Department is a member, collaboration agreements in the agricultural field with several countries, multilateral and bilateral liaison with Botswana, Lesotho and Swaziland and the TBVC countries, as well as agricultural projects financed by the Department of Foreign Affairs. In addition the Directorate has various administrative tasks arising from the professional/technical functions of the Department.

Biometrical and Datametrical Services
Agriculture Building, Beatrix Street, Private Bag X116, Pretoria 0001

Dr J.P. Jooste: Director
Mr J.N. de Bruyn: Deputy Director

The Directorate is responsible for biometrical and datametrical services to the Department.

Financial Assistance
Opera-Plaza Building, Bank Lane, Church Street, Private Bag X118, Pretoria 0001

Mr J.H. Smit: Director
Mr M.F. Jordaan: Deputy Director
Mr P.J. Minnaar: Deputy Director
Mr D.K. Henrico: Deputy Director

To provide financial and/or other assistance to deserving farmers and farming enterprises with a view to promoting the agricultural industry by means of loans in terms of various assistance schemes, the sale or leasing of immovable or movable property of the State that is suitable for farming purposes, and the institution of protective measures in the form of the suspension of legal proceedings against farmers pending the possible granting of one or other form of assistance and arranging for farmers to compound with their creditors. The Directorate administers the Agricultural Credit Act (Act 28 of 1966) and the Designated Areas Development Act, 1979 (Act 87 of 1979).

Irrigation Engineering
Private Bag X515, Silverton 0127

Mr F.J.C. Hugo: Chief Engineer
Mr F.B. Reinders: Deputy Chief Engineer
Mr A.A. Louw: Deputy Chief Engineer
Mr A.M. Meyer: Deputy Chief Engineer
Mr H.J. van Staden: Deputy Chief Engineer
Mr D.J. du Rand: Deputy Chief Engineer
Mr K.O. Bang: Deputy Chief Engineer
Mr P.J. Maritz: Deputy Chief Engineer

This Directorate resides within the Chief Directorate Agricultural Engineering and Water Supply and is responsible for research, development, evaluation and technology transfer regarding irrigation equipment and irrigation planning. The Directorate develops irrigation schemes, administrates irrigation boards and handles applications for financial assistance in terms of the irrigation subsidy scheme.

Soil Conservation and Drilling Services
Private Bag X515, Silverton 0127

Mr J. Veenstra: Chief Engineer
Vacant: Deputy Chief Engineer
Mr P.J. Strumpher: Deputy Chief Engineer
Mr H.W.P.W. Strück: Deputy Chief Engineer

The functions of this Directorate, which resides within the Chief Directorate Agricultural Engineering and Water Supply, entail research, development and special investigations in the field of soil conservation engineering, planning, design and construction of key soil conservation works; provision of engineering advice to soil conservation technicians in the Regions; administration of subsidy schemes for soil conservation, bush control and flood assistance. The Directorate manages the Departmental water drilling service by means of physical drilling and the relevant inspection services through 17 drilling inspectorates. It also administrates the drilling subsidy scheme.

Agro-ecological Regions

The seven Regional Organisations of the Department are responsible, within their respective geographical areas, for the planning, development, promotion and application of farming systems based on optimum land use.

Each Region provides an extension service in which the soil conservation effort is integrated and which also covers every aspect of farming. The research services are directed to the collation and releasing of scientific knowledge for the optimum use of the natural agricultural resources. The research personnel is also responsible for specialist extension work and for supplying training services to the agricultural colleges.

Eastern Cape Region
Private Bag X15, Stutterheim 4930

Dr E.A.N. Engels: Director
Mr P.F. du Toit: Deputy Director (Research)
Dr D.M. Rix: Deputy Director (Extension)

Research Stations - Dohne (Stutterheim) (central research station) and Bathurst (Port Alfred).

A number of experiments are also carried out at East London.

Free State Region
Glen College of Agriculture, Private Bag X01, Glen 9360

Mr J.E. Volschenk: Director
Mr I. du T. van der Merwe: Deputy Director (Extension)
Mr P.S. van Heerden: Deputy Director (Research)
Glen College of Agriculture

Research Stations/Experiment Farms - Glen (central research station), Armoedsvlakte (Vryburg) Koopmansfontein (Barkly West), Rietrivier (Herbert), Sandvet, Upington complex and Vaalharts (Jan Kempdorp).

Highveld Region
Private Bag X804, Potchefstroom 2520

Dr J.W. Snyman: Director
Mr J.P. van Niekerk: Deputy Director (Research)
Mr L.M. le Roux: Deputy Director (Extension)
Potchefstroom College of Agriculture

Research Stations/Experiment Farms - Potchefstroom complex (central research station), Bethlehem and Swartland (Ventersdorp) (gousiekte research).

Karoo Region
Grootfontein College of Agriculture, Private Bag X529, Middelburg, C.P. 5900

Mr H. Steynberg: Director
Dr M. Vorster: Deputy Director (Extension)
Dr D. Wentzel: Deputy Director (Research)
Grootfontein College of Agriculture

Research Stations/Experiment Farms - Grootfontein, Middelburg, C.P. (central research station), Carnarvon, Tarka Conservation Area, Hales Flats and Jansenville.

Natal Region
Private Bag X9059, Pietermaritzburg 3200

Dr C.N. MacVicar: Director
Mr S.D. le Roux: Deputy Director (Extension)
Dr C.F. Sievers: Deputy Director (Research)
Cedara College of Agriculture

Research Stations/Experiment Farms - Cedara (central research station), Drakensberg complex (Estcourt), Northern Natal (Dundee), Kokstad and Pongolapoort (Makatini).

Transvaal Region
Agrivaal Building, c/o Edmund and Hamilton Streets, Private Bag X180, Pretoria 0001

Dr A.D. Venter: Director
Mr F.F.M. van Aswegen: Deputy Director (Extension)
Dr M.K.S.L. von la Chevallerie: Deputy Director (Research)
Lowveld College of Agriculture

Research Stations/Experiment Farms - Roodeplaat (central research station), Soutpan (Pretoria), Athole (Amsterdam), Loskop (Groblersdal), Mara (Louis Trichardt), Messina, Nooitgedacht (Ermelo) and Towoomba (Warmbaths).

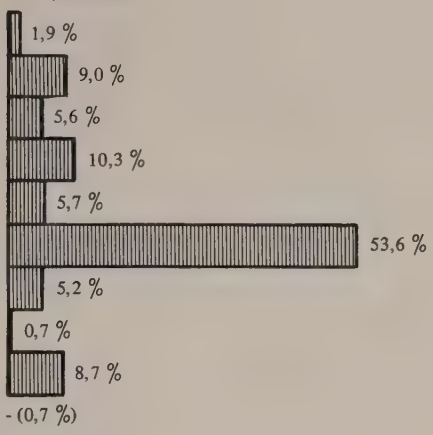
Winter Rainfall Region
Private Bag, Elsenburg 7607

Dr J. de V. Burger: Director
Mr A.F. Kriel: Deputy Director (Extension)
Mr M.C. Walters: Deputy Director (Research)
Elsenburg College of Agriculture

Research Stations/Experiment Farms - Elsenburg, Mariendal (Stellenbosch), Langgewens (Moorreesburg), Nortier (Lambert's Bay), Oudtshoorn, Outeniqua (George), Tygerhoek (Riviersonderend) and the Worcester Veld Reserve.

EXPENDITURE: 1 APRIL 1989 TO 31 MARCH 1990

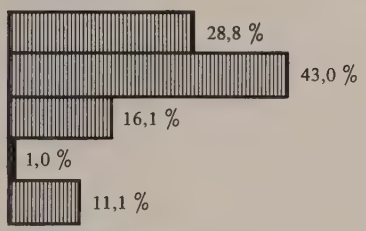
TOTAL EXPENDITURE — **R692,6 million**



1. Administration
2. Plant production promotion
3. Animal production promotion
4. Agricultural resource utilisation
5. Entrepreneurial development
6. Agricultural financing
7. Establishment of State-aided water schemes
8. Operation of State water schemes
9. Associated and auxiliary services
10. Internal charges

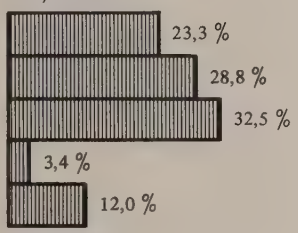
1. ADMINISTRATION (HEAD OFFICE) — **R13,1 million**

2. PLANT PRODUCTION PROMOTION — **R62,2 million**



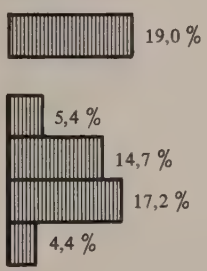
1. Agronomic research
2. Horticultural research
3. Plant protection research
4. Advisory services
5. Administration and other

3. ANIMAL PRODUCTION PROMOTION — **R38,5 million**



1. Animal production and animal products research
2. Veterinary research
3. Livestock improvement schemes
4. Advisory services
5. Administration

4. AGRICULTURAL RESOURCE UTILISATION — **R72,0 million**



1. Resource research
2. Resource utilisation research:
   - :Crops
   - :Animals
   - :Pastures
   - :Farming systems
3. Agricultural production economics research
4. Soil conservation research
5. Resource conservation
6. Administration

5.	**ENTREPRENEURIAL DEVELOPMENT**	**R39,7 million**
1.	Extension services	25,4 %
2.	Advisory services	8,6 %
3.	Services to other bodies	1,0 %
4.	Formal training	26,9 %
5.	Agricultural engineering services	3,8 %
6.	Administration	34,3 %
6.	**AGRICULTURAL FINANCING**	**R371,1 million**
1.	Agricultural credit account	10,5 %
2.	Subsidies	85,8 %
3.	Administration and other	3,7 %
7.	**ESTABLISHMENT OF STATE-AIDED WATER SCHEMES**	**R35,7 million**
1.	Construction of State-aided water schemes	50,1 %
2.	Water drilling services	36,7 %
3.	Professional regional services	12,6 %
4.	Administration	0,6 %
8.	**OPERATION OF STATE WATER SCHEMES**	**R5,1 million**
9.	**ASSOCIATED AND AUXILIARY SERVICES**	**R60,0 million**
1.	Botanical research	–
2.	Molecular biological research	2,3 %
3.	Biometric and datametric services	4,7 %
4.	Payments to universities and scientists (research)	3,0 %
5.	Contributions in respect of international and national symposia and congresses	0,5 %
6.	Development of State agricultural land	–
7.	Chemical services	4,2 %
8.	Minor works	2,5 %
9.	Maintenance services	46,7 %
10.	In-service training	2,3 %
11.	Agricultural information services	13,5 %
12.	Liaison services	2,8 %
13.	Relief of distress	–
14.	Job creation	9,5 %
15.	Groot Constantia-state Estate	–
16.	Administration and other	8,0 %
10.	**INTERNAL CHARGES**	**- (R4,8) million**

PLANT PRODUCTION PROMOTION

AGRONOMY RESEARCH

Summergrain

Entomology

Research has shown that the maize stalk borer lays more eggs over a longer period on grass crops with a higher sucker potential. Rotational feed crops such as babala and fodder sorghums can therefore lead to increased stalk borer infestations in maize.

An explanation was found for the observation over many years that serious cutworm infestations are not always in proportion to the number of winter weeds on maize lands. Cutworm larvae show a definite preference for certain types of winter weeds, which means that infestation relates to the weed spectrum rather than to the number of weeds.

By artificial infestation in grain sorghum it was found that the sorghum borer *Chilo partellus* causes more damage than the maize stalk borer *Busseola fusca*. Where the two pests occur together at average infestation levels, chemical control measures have to be directed only at the sorghum borer.

A number of maize genotypes originating from Mississippi, USA, have been found which have a high measure of resistance to the maize stalk borer. This is the first time that such a high resistance to the maize stalk borer has been established and the finding could play an important role in future resistance breeding programmes.

Pathology

Research on ear rot has shown that the penetration of the fungus into the plant is enzymic in nature. A method has been developed for the artificial infestation of plants by applying a spore suspension during beard appearance. This should be more effective than the conventional American methods.

Small grain

Plant improvement and grain quality

The Department's **winter wheat breeding programme** is being carried out at Bethlehem for the Eastern Free State and at Kroonstad for the Western Free State. Elite trials are being planted in 17 places in the Free State.

The winter wheat breeding programme had to make considerable adjustments during the past season in order to meet the new requirements for release in respect of bread class and resistance to the Russian aphid. The new cultivar Letaba has been released for areas 11 and 12.

The **spring wheat breeding programme** which provides for dryland, irrigation and soft types of wheat is being carried out at eight experimental farms in the northern provinces and four in the Cape Province. In addition, elite trials are also being planted over a wide area of the Winter Rainfall Region.

Significant adjustments also had to be made in this programme in respect of quality requirements and additional resistance to eye-spot. As a result of the new quality requirements two potentially very outstanding cultivars were sacrificed.

The **soft wheat breeding programme** was launched on two experimental farms and five lines have already been identified.

Durum breeding is done in the Riet, Rama and Fish River areas. USD 8712 has been released provisionally from this programme. It has excellent standing abilities, yield potential and quality.

The **barley breeding programme** is carried out mainly at Stellenbosch and on Tygerhoek at Riviersonderend. At present there are three lines with outstanding agronomic features that are *Rhynchosporium* resistant.

The **oat breeding programme** is limited in extent. A new cultivar, Sederberg, has been released for the Western Cape. It has complete resistance to crown rust and its yield overshadows that of all existing cultivars.

Entomology

At present the Russian wheat aphid is still the most important wheat pest in the country. During the year good progress was made with the incorporation of genetic resistance to the pest in South African wheat cultivars. Another new source of resistance has been identified, which brings the current total number of resistance sources to five.

During 1989 a natural enemy of the Russian wheat aphid, the parasitic wasp *Aphidius matricariae*, was imported from Turkey. Attempts will be made to establish the parasite in the field, particularly in combination with genetically resistant cultivars.

Tillage

At Bethlehem, tillage practices are evaluated in respect of the storage of ground water during the summer. The results show that conventional tillage, in comparison with mulching and zero tillage, has the most advantages under the specific environmental conditions. The burning of plant residues had no negative effect on yield and in the presence of root diseases it resulted in significant yield increases.

Trials with wheat on dryland at Hoopstad and

Wesselsbron in the Highveld Region show that the optimum sowing density is influenced by the cultivar and the quantity of stored ground water at planting time. If the ground water is sufficient, Karee produces the highest grain yield at 25 kg seed/ha, whereas lower sowing densities of 10 to 15 kg seed/ha produce better results during drier seasons.

In the Winter Rainfall Region the elimination of soil compaction caused by implements is being investigated with different tillage methods. Results have shown that deep tillage with a broad-based tined implement (450 mm) or mouldboard plough (300 mm) can eliminate the compaction and produce higher yields.

Cultivar adaptation and physiology

By means of a well-planned cultivar evaluation programme, guide-lines for cultivar choices are made on a regional basis. This information is summarised in a publication which is distributed annually during March to small grain producers. In this way, every small grain producer in South Africa is informed in respect of cultivars, planting time and planting density.

Unfavourable environmental conditions after the flowering stage have a direct effect on grain yield. Ground water shortages and heat waves are common during the grain filling stage. Cultivars differ in respect of grain-filling features and this can have a great influence on cultivar selection. Grain-filling rates and grain-filling duration make the largest contributions to yields, with grain-filling rate being the most important. Cultivars with a high grain-filling rate appear to be the better producers.

In cultivar trials in the Winter Rainfall Region the new cultivars Adam Tas and Nantes, along with Palmiet and Dias, were among the four best. Dwyka and SST25 performed poorly in most cases.

The spraying of wheat with three growth regulators, *chlormequat, uniconazole* and *paclobutrazol*, reduced stalk lengths by 6 to 20 cm, increased the crop index and raised the average grain yield by 17,9 %, 25,8 % and 30,9 %, respectively.

Plant nutrition

The results obtained during 1989 from the NPK calibration studies in the various summer rainfall regions do not show any great deviations from the current fertilisation guide-lines. This is in contrast to the previous season when above-average yields and outstanding reactions were obtained from nitrogen fertilisation, in particular.

The soil acidity research programme shows that wheat yields are influenced negatively when the acid saturation of the soil is above 10 %. It also appears that in practice the genetic variation in cultivars in respect of aluminium resistance can be used as an aid to make wheat cultivation in more acidic soils possible.

Weed control

The routine testing of new cultivars and lines for herbicide sensitivity enables plant breeders to eliminate sensitive material continually. For the purpose of chemical control, the safest growth stage for the application of various herbicides to wheat and rye was determined and published.

Wild oats are at present the most important weed in all the wheat-cultivating regions in South Africa. In the winter rainfall and irrigation areas this weed is being controlled chemically with varying degrees of success. In the summer rainfall areas two new herbicides have been released in the past year which for the first time control wild oats effectively under dryland conditions.

In the Winter Rainfall Region 120 wild oat plants/m^2 in wheat reduced the yield by 46,4 %. An increase in the sowing density of wheat from 98 to 249 plants/m^2 had a positive suppressing effect on wild oats and increased the yield by an average of 40 %.

At Langgewens in the Winter Rainfall Region trial results over 2 years have confirmed that wheat yield was reduced by 37,6 % where the application of chemical herbicides for wild radish control was postponed from 15 to 56 days after sowing.

It was found that *Bromus diandrus* seed germinates best if it is placed 30 mm deep. This must be kept in mind where wheat is cultivated at a shallow level in monoculture. Because no herbicide against *Bromus diandrus* in wheat is registered, the best control strategy is to incorporate a legume crop in a rotation system so that this weed can be controlled chemically.

Plant pathology

Resistance breeding against air-borne diseases receives high priority. Great success has been achieved with the incorporation of effective resistance genes against stem rust in existing wheat cultivars. At present a new strategy for leaf rust resistance is being followed which promises to result in longer-lasting resistance.

Differences in resistance in wheat cultivars to brown ear disease have been established and further work is being planned to combat this disease. Breeding for resistance to eye-spot disease began recently.

Intensive investigations into the cause of leaf diseases in barley have led to the identification of resistant lines with good quality and agronomic features.

Guide-lines in respect of planting date, fertilisation and methods of tillage have been found to control diseases such as ear scorch and foot-rot to a great extent.

During the year eye-spot and foot-rot have assumed serious proportions in wheat in the Swartland. Over the past 3 years rotational cropping with medics, lupins and oats on the experimental farm Langgewens has reduced the incidence of

lodging, caused by eye-spot disease, from 22,8 % in the wheat/wheat system to an average of 1,28 %. An average decrease of 67,2 % was observed in the incidence of foot-rot in the wheat rotated with medics, lupins or oats. The yield of wheat after medics, oats or lupins was on average 26,7 % higher than that of the monoculture wheat.

Oil and protein seeds

Groundnuts

At present the industry depends largely on the departmental programme. For years the cultivar Sellie was the only commercial cultivar in South Africa. The cultivars Norden and Harts were released in 1988. Both cultivars show resistance to black pod rot (*Chalara elegans*).

The release of the cultivars has aroused new interest in groundnut production. In the Douglas area the cultivar Harts has opened a new production area for groundnuts. Owing to the short growth cycle, Harts is used effectively in a crop rotation system. At present Norden constitutes almost half of the groundnut production of the Vaalharts irrigation district. The cultivar has a high yield potential, which is reflected in the higher income realised.

Adaptation studies with groundnuts indicate that certain new cultivars may be well adapted to areas where groundnuts could not be cultivated previously. If this provisional result is confirmed, groundnut production can be extended to parts of the Highveld and the Eastern Free State, which may have a positive influence on the industry.

Aflatoxin - Research has shown that *Aspergillus flavus* is, to a large degree, seed-borne and that the dominant species is *A. parasiticus*. Investigations have also shown that this organism penetrates tissue directly. There is not a very strong link between the endoparasitic nematode *Ditylenchus destructor* and the tissue susceptibility to and infestation by *A. flavus*.

Sunflowers

During the past few years the breeding programme at the Oil and Protein Seed Centre has been directed at development work. Excellent inbred sunflower lines were released and are used in hybrids for both local and foreign industries. Cytoplasmic male sterile and restorer lines are being developed. To broaden the genetic variability of sunflowers, successful inter-specific crossing was done and attention has already been turned to the development of a cytoplasmic male sterile system of these sources.

Fertilisation studies with sunflowers have shown that natural or residual soil nitrogen can vary widely and sometimes makes a big contribution to the nitrogen nutrition of the crop. This implies that less fertiliser can be used. If soil nitrogen analyses were done routinely, the result could be large savings in fertiliser costs in some cases, which would limit input costs without forfeiting yield.

A long-term study with different crop succession systems began during the past season with the main objective of studying the principles involved in crop rotation and comparing systems and crops in respect of water consumption and efficiency.

A trial is being carried out with sunflowers at Potchefstroom on soils with a high clay content. It has been found that when the plant population is increased in row widths of 1,8 m to 45 000 plants/ha, the plants grow higher and have thinner stems. This leads to more lodging and lower seed yields.

Soya beans

On the basis of the 1989/90 trial results of the Oil and Protein Seed Centre, elite soya bean lines were selected that have a high yield potential and a wide adaptation in different production areas. Promising lines with a good adaptation in the warmer areas were selected.

Good progress has been made with the development of high-protein cultivars through the selection of lines with up to 45,8 % protein as against a cultivar average of 38 % on a moisture-free basis.

Dry beans

The emphasis in the dry bean research programme falls more and more on the breeding of cultivars that are able to produce high yields with a minimum of input in respect of disease control and which produce a stable yield under a wide variety of climatic conditions. With this objective in mind, a large number of breeding lines from abroad were tested. Cultivars with resistance to diseases such as rust, halo blight and ordinary scorch have been identified and they will be used in breeding programmes.

The inclusion of Cedara as a testing site for large seed breeding lines was very successful because every season a very high level of rust infection occurs, compared with the very sporadic occurrence on the Highveld.

The lack of suitable cultivars is one of the main factors restricting dry bean production in Natal.

The results of the past national dry bean cultivar trials have shown that there are a considerable number of small white, brown haricot and spotted sugar bean breeding lines that have a high yield potential and an improved level of disease resistance. Quality features in the small white canning beans are still a limiting factor. It is expected that a few breeding lines will be approved for presentation for the variety list.

Lupins

The lupin breeding programme of the Oil and Protein Seed Centre has developed into a fully-fledged programme. Recently, the first nine cultivars were tested in the cultivar evaluation programme. Five new cultivars were submitted for

plant breeders' rights. The breeding programme provides for the development of cultivars for both winter and spring plantings.

In Natal early spring plantings of sweet white lupins showed promise for seed production under dryland conditions. The crop adapted the best in the cooler regions such as Kokstad, where the average seed yield is 4,5 t/ha. The mist belt area is marginal for spring plantings, whereas the warm areas are unsuitable for commercial cultivars.

White lupins also show promise in winter plantings under irrigation in crop rotation with wheat in parts of Natal which do not get severe late frost.

A very promising sweet, yellow lupin (*Lupinus luteus*), was identified from the five cultivar evaluation trials in the Winter Rainfall Region. This lupin may meet an urgent need, particularly in the Citrusdal-Clanwilliam area.

Fusarium oxysporum and *Rhizoctonia solani* cause widespread diseases of *Lupinus albus* on the Highveld. The two commercial cultivars, Kiev and Buttercup, are highly susceptible to the diseases. There were great differences in the pathogenicity of the various isolates of the pathogen and there were also differences in susceptibility of the various cultivars.

The pathogen infects the host plant at different stages. *R. solani* attacks the plant in the seedling stage, whereas *F. oxysporum* first attacks the plant in the adult stage. Fungicide seed treatments showed a limited measure of success. Herbicides apparently increase the occurrence of the diseases.

Cowpeas

The evaluation of the first series of entrants to the germ plasm collection for hay and seed yield was completed. The evaluation for disease tolerance is continuing.

Susceptibility to viral diseases remains a serious problem and it is particularly late plantings which are risky.

Other crops

Tobacco

Flue-cured tobacco - The breeding line OD272 (TL12/48 - 33 X C298) was evaluated successfully and promoted for commercial evaluation in phase 2 trials. The breeding lines OD212 and OD224 have already been tested in phase 2.

Air-cured tobacco - The air-cured cultivar CDL3 was released for the production of light air-cured tobacco and good comments have been received from producers. Two blackleg-resistant air-cured combinations, C11 X WOSB and W. Bar, were promoted for the dark pool after phase 2 evaluation.

Burley tobacco - At present climatological information is being evaluated to determine which areas are suitable for Burley production. The Burley cultivar TN86 was released and seed was made available to producers. The sterile male TN86 cultivar will be evaluated for a second season in the phase 1 trial.

Oriental tobacco - A hybrid vigour study is being carried out on oriental tobacco after certain F1 hybrids performed excellently last season. Breeding for resistance to root knot nematode is progressing well and is inbred with male sterility.

Crop production - Because of a high demand for orange tobacco, research started at Groblersdal to determine which factors play a role. The initial results indicate that the flue-cured tobacco cultivars OD86 and OD224 produced a significantly higher percentage of light orange leaf where they were fertilised at 130 N/ha and topped to 14 leaves.

Plant nutrition - Good progress was made in respect of the forecasting of nitrogen production and the movement of nitrogen in the soil. The ultimate aim is to be able to forecast in all circumstances how much nitrogen occurs and where it occurs in the soil profile. The rate of root development is related to the production of nitrogen in the soil.

The poor uptake of phosphate from certain soils and the disproportion of potassium, calcium and magnesium, which causes great problems in sandy soil in particular, are being investigated further.

A survey shows that the micro-element content of tobacco in certain areas is already lower than the accepted minimum.

Diseases and pests - Once again, surveys were made in the Eastern Transvaal Lowveld, in the Loskop irrigation scheme, on the Springbok Flats and in the Western Transvaal. The general tendency was a reduction in the occurrence of the viral diseases CMV and PVY in all the areas. Only in the Western Transvaal was there a relatively high occurrence of PVY.

However, spotted wilt viral disease increased during the past season and was a problem particularly in the Ohrigstad Valley in the Eastern Transvaal and in the Skuinsdrif area in the Western Transvaal. This may be attributed to the increasing cultivation in these areas of coriander and onions, which are alternative host plants for the spotted wilt virus, and for thrips, which transmit the disease.

It has been found that the presence of certain weeds and rotational crops in the vicinity of tobacco lands increases the occurrence of tobacco viral diseases. During the past season these plants were eliminated on a large scale in the Lowveld, in the Loskop irrigation scheme and on the Springbok Flats and there was a significant decrease in the occurrence of diseases such as CMV and PVY, in particular. It was also found that wild dagga is an alternative host plant for both CMV and PVY.

Research is being done on the survival of *Pseudomonas solanacearum* in the soil and the effect that rotational crops have on the pathogen population. Provisional results show that the protogene moves down to as deep as 2 m into the soil in unfavourable conditions.

In trials with nematicides no significant

difference was found in the effectiveness of EDB with a post-harvest or pre-planting application.

Four tobacco cultivars, *viz.* TL33, Burley 64, CDL28 and Pale Yellow 13, were examined for bollworm during the season. During the pre-flowering stage the most eggs were laid on TL33 on the top nine leaves. More eggs are laid on top of the leaf than underneath it. The small suckers are attacked in plants that are cut down, but no cultivar preferences could be established.

Cotton

Plant improvement - A complete breeding programme is being carried out at four places, *viz.* Rustenburg, Loskop, Vaalharts and Upington. New breeding material is generated every year and the best breeding lines are identified.

In the past season 70 crossings were made at Rustenburg, 68 at Loskop and 21 at Vaalharts. Of the new breeding lines imported from the USA, 265 were planted at Rustenburg, 101 at Loskop and 113 in Vaalharts. Some of these lines are as much as 45 days earlier than the commercial standards used. However, the problem is that the early breeding lines produce lower yields. Crossings are made with breeding lines with short growing seasons to combine earliness with better plant structure and higher yield.

During the past season two new cotton cultivars were released from the breeding programme, *viz.* Letaba and OR19. The cultivars produce a good yield with an acceptable fibre quality.

Crop production - Cotton planted in rows 75 cm wide produced significantly higher yields than with conventional 100 cm spacing. Cotton plantings in December produced yields 41 % lower than early plantings in October. The new cultivar Letaba produced the highest yield, with a fine fibre of good length.

In trials with herbicides it was found that MSMA can be used very successfully, particularly if it is applied to cotton at a very early stage. It was also found that MSMA at normal dosages did not cause phytotoxicity in young growing cotton.

Under favourable growing conditions which are maintained throughout the growing season it is necessary to control the vegetative growth of the cotton plant with a growth-inhibiting substance. Weekly sprayings with mepiquat chloride at 125 mℓ/ha from the start of the budding stage produces a high seed cotton yield of 7 500 kg/ha.

National cotton cultivar trials for the release of new cultivars were carried out in 36 trials with 16 cultivars in the cotton producing areas of the country. Four of these cultivars are awaiting registration and the other 12 are registered cultivars from which regional recommendations are made.

Diseases and pests - The spread of cotton stem weevil was investigated throughout the country. The insect has not yet spread further than the known distribution areas in the Eastern Transvaal Lowveld and Northern Natal.

Trials show that cotton stem weevil infestation can reduce the yield of newly planted cotton drastically, depending on the time and intensity of the infestation.

Cotton breeding lines with various morphological characteristics are being evaluated for resistance to the bollworm complex and flea beetles. The number of sprayings necessary for bollworm control shows that the villose lines (six sprayings) are the most attractive to bollworms, whereas the high gossypol and glabrous lines (three sprayings) are the least attractive. The yield in all the cultivars is increased by chemical control of the bollworms.

HORTICULTURAL RESEARCH

Pome, stone and other fruit

Apples

Breeding and evaluation - The Fruit and Fruit Technology Research Institute planted a further 4 793 apple seedlings at Drostersnes, where a total of 20 224 seedlings are being evaluated at present. Nine promising selections were identified in the Drostersnes planting and were promoted to phase 2 evaluation trials. Four cultivars were released to the industry, namely Anna (Israel), Akane (Japan), Braeburn (New Zealand) and Le Vant (local seedling).

Crop control - The fruit size prediction model of the Fruit and Fruit Technology Research Institute proved to be sufficiently accurate to maintain an average mass per fruit of 140 to 145 g in experimental orchards during the past 5 years. The number of cartons of larger apples was found to be related to the number of chilling hours which occurred in the area during the past 10 years.

Stem-end russet - Russeting is still of great concern to apple growers. During the 1989/90 season stem-end russet was correlated with stalk length and cavity depth. Russeting increased with increasing stalk length and cavity depth. Ten to 15 % of the epidermis of a mature apple was found to originate from the epidermis that covers the upper part of the pedicel at bloom.

Delayed foliation and sunburn - The replacing of 40 % shadecloth with 20 % netting caused a marked increase in both the number and the size of the fruit during the following year. It was evident that the reduction in crop levels and fruit size caused by the 40 % shade would not be economically viable even when sunburn was eliminated.

Nutrition - There was a tendency for russeting of apples to increase with a decreasing extractable phosphorus content in the soil, especially at the higher nitrogen fertiliser rates. Preliminary results indicate that the present guide-lines on fertiliser requirement could be decreased by at least a third and possibly half, if irrigation is well scheduled and leaching of nitrogen is minimised.

Codling moth - Codling moths lay eggs at random with respect to the top and bottom of trees.

On Granny Smith 13 % of eggs were deposited on fruit, 26 % on wood and 61 % on leaves. The number of eggs increased with an increase in the number of fruit per spur. Spurs with three to four fruits had 50 % more eggs than spurs with one or two fruits.

Banded fruit weevil - There are indications that adult banded fruit weevils may be developing resistance to synthetic pyrethroids. None of six pyrethroids gave acceptable control of the insect in the Elgin area, where these insecticides have been used extensively for a number of seasons, but up to 93 % mortality of weevils was obtained in the Langkloof area, where pyrethroids had been little used.

Nematodes - A plant parasitic stubby root nematode species was found in South Africa for the first time. This nematode was observed in all the main apple production areas and occurred in about 20 % of sample orchards.

Ethylene - Results of a study on the effect of high ethylene concentrations at -0,5 °C and elevated storage temperatures on fruit quality confirmed that it is not essential to remove ethylene from the storage atmospheres. Generally, storage temperature had a greater effect than ethylene concentration. However, the incidence of core flush in Granny Smith increased after a storage period of 7 months at high ethylene concentrations. A good relationship was found between the increase in internal ethylene content of Starking and Granny Smith apples and the estimated harvest date. Internal ethylene content can possibly be used as an additional parameter for maturity indexing.

Pears

Breeding and evaluation - Eleven promising selections were promoted to phase 2 evaluation trials in which 146 cultivars, clones and selections are being evaluated. The first local pear selection, named Rosemarie, has been identified for release. This is a very attractive selection with a red blush and of excellent dessert and canning quality which could become a very important cultivar in the near future.

Rootstocks - Packham's Triumph trees on the quince rootstock C51 produced an exceptionally heavy crop during the past season. Consistent heavy crops warranted the release of this rootstock. A commercially viable method for the micro-propagation of BP1 and BP3 rootstocks was developed.

Specific replant disease - A simple practical method was developed to predict if a specific replant disease of pears is present in a soil. This will enable producers to decide if fumigation of a soil is necessary when re-establishing pear orchards.

Ripening and storage - The study on the effect of partial ripening before retail marketing on the quality of Packham's Triumph and Forelle pears progressed well. Packham's Triumph ripened normally during storage under simulated marketing conditions, but, unlike Forelle, did not develop a yellow colour. Doyenne du Comice and Forelle pears were stored under controlled atmosphere conditions of 1 % oxygen and 0 % carbon dioxide for 7 months without an appreciable loss of quality. The maximum storage period for Beurre Bosc pears was approximately 4 months.

Peaches and nectarines

Breeding and evaluation - More than 3 000 peach seedlings were established in phase 1 evaluation orchards at the Fruit and Fruit Technology Research Institute, where 35 000 seedlings are being evaluated. Fifty-four promising selections, including 28 nectarines, were identified during the past year. Approximately 300 promising selections will also be evaluated at Roodeplaat for the northern areas. Phase 2 evaluation trials consist of 86 peach and nectarine selections. The newly-bred cultivars Goudmyn, Summer Giant and Nova Donna will be released in the coming year and six other selections were identified for possible release in the next year.

Ring-barking - Ring-barking of Sunlite nectarines was continued and the early nectarine Mayglo was included in the trials. Fruit size and early maturity could be improved significantly in both cultivars. Split pit occurred in Sunlite nectarines with early ring-barking.

Fertilisation - For the successful application of nitrogen through an irrigation system, it is important to know the source of nitrogen contained in the commercial soluble fertiliser since it is crucial to the decision on when the fertiliser pulse is to be injected during irrigation. If urea is the nitrogen source or if leaching is required because of saline irrigation water, the fertiliser pulse should be injected during the fourth quarter of the irrigation cycle. With ammonium as the nitrogen source, injection can be during the second quarter on heavier soils and the third quarter on sandy soils.

Nematodes - Fenamiphos suppressed increases of root knot nematode larvae in peach orchards. Treatments in which fenamiphos was applied two or more times during the first number of growing seasons produced significantly higher fruit yields.

Storage - Canning peaches were successfully stored under controlled atmosphere conditions of 1,5 % oxygen and 1,5 % carbon dioxide or 2 % oxygen and 5 % carbon dioxide. After a cold-storage period of 4 weeks, the loss of mass was negligible compared with conventional cold storage and the quality of the canning fruit was still good. Nectarines stored under controlled atmosphere conditions for 5 weeks ripened normally at 10 °C and had a good flavour. Maturity at harvest, however, was important because immature fruit did not store well.

Dehydration - An additional computer-controlled dehydrator was commissioned during the past season at the Fruit and Fruit Technology Research Institute and the range of experiments conducted was extended. Promising results were obtained with the drying of Elberta and Kakamas peaches without the use of sulphur dioxide. The new facilities for the application of

sulphur dioxide were fully utilised the past season. Sulphur dioxide was applied under rigidly controlled conditions followed by tunnel dehydration. This facilitated basic studies on the mechanisms involved in sulphur dioxide application.

Plums

Breeding and evaluation - A further 3 452 seedlings were established in phase 1 evaluation plots at the Fruit and Fruit Technology Research Institute, where 18 429 seedlings are being screened at present. Thirty cultivars and selections are also being screened in phase 2 evaluation trials. The cultivar Celebration has been released and its keeping quality will be monitored during the next season before commercial plantings can be recommended. The plum rootstock Maridon, which seems to induce resistance to bacterial canker, will also be released to the industry.

Crop control - Investigations regarding the chemical thinning of plums have been concluded and the results are being analysed. The effect of heavy crops on crop and fruit size during the following season indicates that early thinning of plums will be imperative to produce consistently heavy crops of good quality fruit.

Fertilisation - A field study on fertiliser requirements, with the emphasis on nitrogen and to a lesser extent liming, is being carried out with plums. Preliminary results indicate that the present recommendations on fertiliser requirement could be decreased by at least a third, and possibly half, if irrigation is well scheduled and leaching of nitrogen is minimised.

Internal breakdown - Research on internal breakdown (browning) and gel breakdown concentrated on conductivity and the quantification of enzymes. Internal conductivity increased during the first 2 weeks of ripening, but decreased during the development of gel breakdown. It was also established that there is significantly less ascorbic acid in fruit with severe internal breakdown than in sound fruit. The activity of enzymes associated with browning tended to increase with increased cold storage periods.

Post-harvest diseases - In a survey of the incidence of post-harvest decay in fruit from different production areas, it was established that *Monilinia laxa* caused most of the decay. The incidence of *Botrytis cinerea* was slightly higher than in the previous season.

When fruit stored at a low temperature was exposed to ambient temperature, water of condensation accumulated on fruit surfaces and was present in sufficient quantities and for long enough to stimulate infection by *B. cinerea*.

Storage - Songold plums stored under controlled atmosphere conditions for 2 weeks followed by storage at 7,5 °C for 2 to 4 weeks ripened normally and had a good flavour. Storage for 6 weeks was also successful, but colour development under simulated marketing conditions was inhibited to some extent.

Apricots

Breeding and evaluation - The number of selections in phase 1 evaluation orchards amount to 15 330 seedlings after an additional 4 800 seedlings were planted during the past season. Twenty promising selections were promoted to phase 2 evaluation trials, where a total of 28 selections are being screened at present. One hundred and fourteen selections were identified for evaluation in the northern areas. The locally bred cultivar Ladisun and the imported cultivar Bebeco will be released this year. Three other selections have been identified for possible release.

Training - The costly trellising systems could not be justified and free standing closed vase systems performed equally well.

Fertilisation - Application of organic fertiliser in the form of chicken manure was not successful and in order to obtain yields which were comparable with the standard recommendations, the nitrogen application rates had to be doubled.

Even on sandy soils the present recommendations on fertiliser requirement could be decreased by at least a third if irrigation is well scheduled and leaching of nitrogen is minimised. Application of compost during soil preparation proved to be beneficial.

Storage - A delay of 2 to 6 days at temperatures ranging from 3 °C to 10 °C before cold storage adversely affected fruit quality. The period of delay had a more significant effect than temperature. Apricots must therefore be packed and cooled immediately after harvest to prevent quality losses.

Cherries

Meteorology - In the Eastern Free State it was shown that during nights when temperatures decreased to below freezing, shading resulted in trunk temperatures not decreasing below 0 °C. During warm days shading resulted in lower temperatures during the hottest part of the day, whereas higher temperatures were recorded behind a shade screen throughout the day on cooler days. Establishment of cherry trees in the Eastern Free State should not be attempted without shade protection.

Storage - Storage in polyethylene wrappings at -0,5 °C extended the storage life of cherries.

Almonds

Cultivars - Two imported Israeli cultivars, namely Volcani 59/4 and Volcani 5, performed exceptionally well in areas with low chilling and were identified for release to the industry. The French cultivar Ferrastar can be recommended only for areas with high chilling with the two pollinators Ferranges and Ferraduel. The application of hydrogen cyanamide proved to be a powerful tool to manipulate the blossom period of almond cultivars and pollinators.

Berries

Breeding and evaluation - Three imported strawberry cultivars, two from the Transvaal and 123 selections were screened in phase 2 evaluation trials during the past year. More than 200 bramble seedlings were evaluated and seven selections have been promoted to phase 2 evaluation trials for further screening.

Fertilisation and irrigation - The application of resin-coated slow-release nitrogen sources resulted in significant increases in production of strawberries. However, the cost of these products may limit their large-scale use. Production of strawberries was significantly affected by irrigation scheduling and drip irrigation did not differ from full-surface irrigation.

Kiwifruit

Fertilisation - A pot trial on the seasonal uptake and distribution of nutrients by kiwifruit vines was concluded. The kiwifruit vine requires large quantities of potassium and, to a lesser extent, nitrogen. Owing to the fact that these nutrients are transported from the leaves to the fruit shortly before harvest, deficiencies may develop in the vine during this stage even though the vine may be well supplied. The need for re-allocation of potassium appears to be related to poor translocation from the roots to aerial parts which, in turn, may be related to water use efficiency. Fertiliser requirements were estimated and will be evaluated in a field trial.

Irrigation - Surprisingly low water use was observed with kiwifruit during January and February, the hottest period of the season. This may be an indication of high stomatal sensitivity and could also be related to lack of translocation of potassium from the roots to aerial parts.

Nutritional value - Chemical analyses indicated that the Vitamin C and mineral nutrient contents of kiwifruit are high, which makes it an acceptable health food.

Bananas

Storage - Controlled atmosphere storage and storage in polyethylene bags extended the storage life of bananas. In bags containing fully-developed bananas, atmosphere modification was substantial and approached the optimum gas mixture of 2 % oxygen and 7 % carbon dioxide which is recommended for controlled atmosphere storage of bananas.

Pineapples

Processing - Techniques to extend the storage life of pineapples by means of partial processing were evaluated. The best preservatives were sugar syrup with the same concentration as the sugar content of the fruit and low concentrations of sodium metabisulphite. Pineapple slices treated in this way could be stored for 6 weeks.

Viticulture and oenology

Soil acidity in the subsoil

The adjustment of soil acidity in the subsoil of existing vineyards is difficult because implements that can incorporate the lime into the soil do not fit between the narrow rows. The movement of different liming materials applied to the soil surface is therefore being investigated in the laboratory and in two field trials.

Within a year after the application of hydrated lime, the pH of a light-textured, loamy sandy soil (Fernwood) near Worcester was increased to a depth of 600 mm so that the danger of aluminium toxicity was eliminated. Calcitic and dolomitic lime increased the pH of this sandy soil up to a depth of only 200 mm. On a heavier clay loam soil (Hutton) in Stellenbosch, the effect of hydrated lime was also measured up to a depth of 600 mm, but the pH was not sufficient to eliminate aluminium toxicity completely.

The liming material did not move into the sandy soil as effectively as was assumed. This indicates that the dense packing of the structureless sand leaves few coarse pores for the physical washing in of liming material. On the heavier Hutton soil, there was apparently a more continuous system of coarse pores along which the lime could wash in.

Available root space

The effect of soil preparation depth under both dryland and irrigated conditions on the performance of vineyards is being established in a field trial at Nietvoorbij. In the first phase of the experiment, from planting until the vineyard begins to come into full bearing in the fourth growing season, it was found that the depth of soil preparation had a great effect on vine development. On dryland, shoot masses increased progressively in the third growing season from 0,17 kg/vine for the shallowest treatment (400 mm) to 0,61 kg/vine for the deepest treatment (1 200 mm). Effective soil preparation could therefore help to bring the vineyards into full bearing at least one year earlier.

On the irrigated stands, shoot masses also increased in line with increasing depth of soil cultivation, and figures were consistently higher than those of their unirrigated peers. It was significant that irrigation could not completely overcome the negative effect of shallower soil preparation.

The allocation of precise soil volumes or marked off root spaces, and the availability of a sophisticated drainage system make the composition of accurate water and nutrient balances possible.

Irrigation of table grapes

In an irrigation trial with Barlinka/Ramsey in the Hex River Valley it was found that drying out to a 50 % plant-accessible water level had no effect on the

vegetative growth, yield and other quality features. Where a 15% plant-accessible water level was maintained from budding to véraison, vegetative growth decreased by 29%, but even so, the harvest was not affected. Where this water level was maintained during the ripening phase, grape colour improved without a reduction in the harvest.

Information obtained from this trial can be used with a class A evaporation pan to schedule the experimentally determined net irrigation requirements of 645 mm over the growing season of the vineyard. The quantity of water is less than that usually used by producers and should serve as a guide-line for the Hex River Valley. Soil water levels of between 85% and 50% can be maintained without causing any water stress in the vine.

In an irrigation and fertilisation trial it was found that 25% of water could be saved with drip irrigation as against other systems. This saving is possible without a reduction in the harvest and indications are that quality has even improved. In respect of nitrogen fertilisation it was found that a too high level of the nutrient leads to poor colour in a black cultivar such as Barlinka.

The compaction of vineyard soils

Research at the Viticultural and Oenological Research Institute has made it possible to successfully predict soil compaction, which is a great problem in our viticultural areas.

Rootstocks for wine grapes

Every year, on a continuous basis, 50 combinations of different scion cultivars and clones, grafted on different rootstock cultivars and clones, are being evaluated for affinity at Nietvoorbij. There are substantial differences between the various graft combinations. The popular 99 Richter generally does not perform so well with many of the scion cultivars. For example, Cabernet franc showed better affinity with Ramsey and 143B Mgt than with 99 Richter.

Plant density

It has been found that closer spacing of vines under dryland conditions causes the ground to dry out a great deal faster than with wider spacing. The result is a negative leaf water potential, which leads to an early closure of the stoma and thus the transpiration is influenced negatively. Therefore grapes in closely spaced vineyards ripen under greater stress conditions than those in wider spacing.

Trellis systems

Photosynthetic activity and light penetration are improved by larger training systems in vineyards. The higher yield of Sultanina on larger training systems can be attributed to an improvement in budding percentage, which occurs as a result of the improved lighting of the basal eyes. The higher harvest mass of Chenel was as a result of the higher bunch mass, which can be attributed to a better photosynthetic effectiveness of the leaves.

Pruning norms

An investigation was carried out to determine whether mathematic formulas used to forecast budding dates of vineyards in Bordeaux (France) can also be used for vineyards in South African conditions. The formulas were tested and adapted by using budding dates over 8 years of 15 cultivars at Nietvoorbij. In 1989 the forecast differed by 1 to 5 days to the actual budding date. The application possibilities of such a forecast model are great, and can help the producer to refine his planning and management.

Foliage management

Foliage management is a practical way of manipulating the vegetative growth in vineyards to increase the quantity and quality of the harvest. For the first time, studies at the Viticultural and Oenological Research Institute have shown which, how many and when leaves can be removed without loss of quality. Results have shown, among other things, that the removal of too many metabolically active leaves in the lower half of the foliage during the early development stage and of the apical parts after véraison to maturation should be avoided. To keep leaves at their photosynthetic optimum, foliage handling must be planned with the greatest of caution. Good foliage management also means that there is better disease control and that grapes can be harvested more easily.

Table grape breeding

The breeding programme at the Viticultural and Oenological Research Institute was strengthened this year by the creation of new nursery facilities with which the seedling capacity can be increased to between 6 000 and 10 000 per annum. During the past year 23 300 seeds of new crossings were harvested and a total of 1 250 seedlings were grafted onto virus-free rootstocks for evaluation for desired features. Four new cultivars were included in the final phase of evaluation, which brought the total to 150. The crossings are evaluated with imported cultivars in winter and summer rainfall areas. During the past year, 365 cultivars were evaluated for their suitability for drying. One of these will be considered for commercial release in the coming season.

Degree of ripeness of table grapes

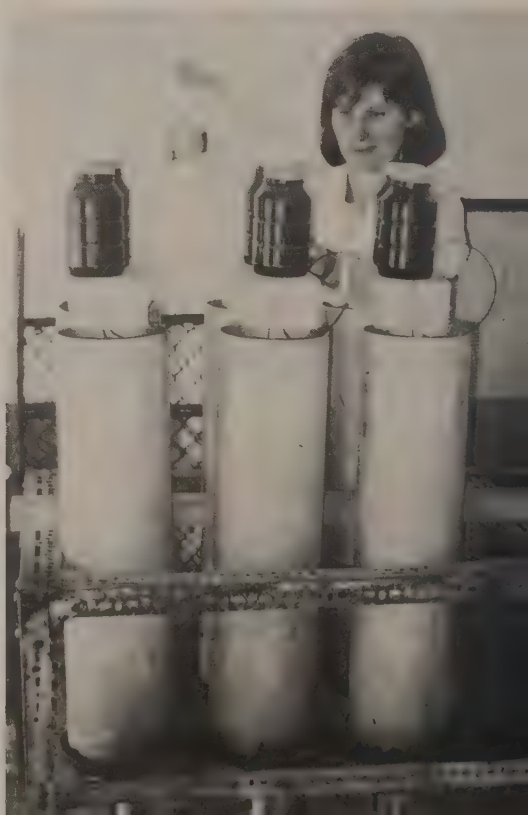
In the search for norms for ripeness and quality, the sugar and acid concentration of table grapes was investigated. Eating quality improved with increased

Laboratory tests at the Viticultural and Oenology Research Institute with grape berries to determine biological control of botrytis by means of bacteria

At the Viticultural and Oenological Research Institute growth cabinets are used for tissue culture where embryos are grown on artificial mediums

Unexpected soil compaction of vineyard soil restricts root penetration to looser subsoil

The movement of surface-applied lime to ameliorate subsoil aciditiy in vineyard soil is determined by means of leaching studies on undisturbed soil nuclei

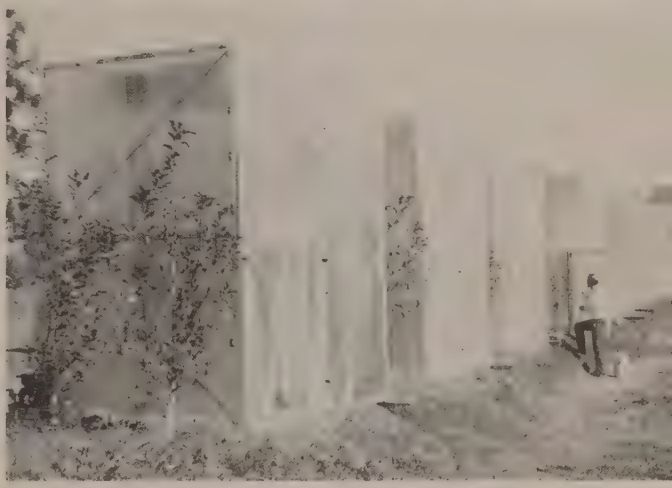


A cross-section of a maize callus that shows the formation of a number of somatic embryos on the edge

A scanning electron micrograph of a fully developed somatic maize embryo

Crushed grape berries and juice are separated by means of centrifugation before plant hormone identification can take place

Ripgut brome (*Bromus diandrus* Roth.) is one of the noxious weeds in grain lands in the Winter Rainfall Region



The daily growth rate of Golden Delicious apples is investigated in growth chambers such as these at the Fruit and Fruit Technology Research Institute

A sophisticated drainage system is used in a soil volume trial with vines to achieve accurate water and nutrient balances

sugar, but at a certain level it was found that quality decreased. It was found that the accepted norm of a specific sugar:acid ratio for quality was not always correct. A specific minimum sugar concentration for each cultivar is proposed as a better norm for ripeness and quality.

Biological control of botrytis

The fungus *Botrytis cinerea* (grey rot) is the main cause of post-harvest decay in table grapes and an intensive preventive spraying programme is being applied to control it. In spite of an expensive spraying programme, losses as a result of botrytis amount to millions of rands annually. An investigation at the Viticultural and Oenological Research Institute indicates that botrytis can possibly be controlled biologically with epiphytic bacteria occurring on vineyards. In one season 80 isolates were found in vineyards and these have a suppressive effect in an artificial medium on the germination and growth of botrytis. With one isolate, even 100% control was obtained.

Biological control of red spider mite

During the past number of years red spider mite has developed into a serious pest of table grapes. Observation over a period of 2 years in a vineyard has shown that red spider mite appeared in February and reached a peak in March. Low populations of a predacious mite (*Amblyseius addoensi*) were also found during this period. After sprayings for the control of mealybugs and snout beetles were drastically reduced, high numbers of the predacious mite occurred in the third season and red spider mite was controlled naturally so that it was virtually not observed anymore. Red spider mite can therefore be controlled biologically if its natural enemy is not killed by indiscriminate chemical sprayings for the control of other pests.

Biological control of eutypa

In laboratory studies it has been found that the wood rotting fungus *Eutypa lata* can be suppressed successfully by a bacterium, *Bacillus subtilis*. Wood rotting is one of the most important problems in the viticultural industry and causes a gradual die-back of vines with an accompanying reduction in the harvest. The fungus enters the vines through the pruning wounds, but the current control measure of covering the wounds is very labour intensive and not very successful.

The biological control of eutypa has also been confirmed by field studies and at present the bacterium is being manufactured for commercial use.

Wine aroma

The free and bound terpene levels in five Gewürztraminer and five Weisser Riesling clones have been determined. There were no significant differences in the Weisser Riesling clones. These findings correspond to results published in Germany. One of the Gewürztraminer clones (N20 Kieselberg) contains particularly low levels of terpene and also gives considerably less fragrant wines. This clone is therefore less suitable for making the typical wines of this cultivar which are sought after precisely for their aroma.

Wine aroma plays a large role in total wine quality. Many local white wines lack sufficient aroma. Glucoside-bound terpenes that may play a role in wine aroma occur in many wine grape cultivars and in some cultivars the concentration of this fraction is much higher than the free terpenes. If these bound terpenes could be released, wine aroma and quality would increase. An attempt has been made to release bound terpenes by means of enzyme preparates, but it was not successful as a result of the low wine pH and glucose inhibition of the enzymes, among other things.

Selection of wine fermentation strains

Strict selection criteria were applied to 80 wine fermentation strains from the yeast collection of the Viticultural and Oenological Research Institute. The 25 strains that passed this first phase test were selected by the industry with 11 other strains and subjected to small-scale fermentation trials in the three different musts. All wines were evaluated by a panel of judges and the yeasts responsible for the two best wines were released for small-scale evaluation by the industry. One of these yeasts performed particularly well and will probably be used during the 1991 season on a commercial scale.

Citrus and subtropical crops

Citrus

Physiology - Research on the citrus small fruit problem showed that no single mineral nutrient within the fruit had any influence on fruit size, but that ratios in which they occur play a role. Tristeza virus infection could not be shown to play a significant part in the problem. An interaction between plant growth regulators and carbohydrate allocation through root growth appears to play an important part.

Nutrition - The ratio of N:K fertilisation and the leaf composition of Valencias plays an important role in crop and fruit size. In the Citrusdal area too large fruit are more of a problem than too small fruit. By manipulating the N:K ratio, optimal fruit size distribution can be obtained. With injudicious application of fertilisers as much as 16% of the crop can be count 40 and bigger, which is normally too large for export.

Upgrading - The breeding programme is progressing satisfactorily and the easy peeler hybrids at Malelane and Addo should produce enough fruit for evaluation purposes within the next year. Ten

navel selections were identified at Nelspruit for inclusion in phase 2 evaluation. About 200 new hybrids were established at Nelspruit. Mutation breeding is still receiving high priority and more than 900 cultivars and selections were irradiated for this purpose.

Ten new rootstock crosses for lemons and five potential rootstocks for navels are included in phase 2 evaluation at five different localities. About 70 trifoliate and grapefruit hybrids were selected for further evaluation. Imported saline and rootrot-resistant rootstocks at Addo are due for evaluation within the next 2 years. Approximately 80 new rootstock crosses made during the past season will be planted in the new season.

Pathology - In the Hazyview and Tzaneen areas the citrus black spot pathogen developed resistance to benomyl. Reversion to a mancozeb programme gave commercial control and the percentage of resistant mutants in the population has declined.

Phytophthora infections are responsible for higher levels of damage than either virus, viroid or citrus nematode infections. The Gou-Touw rootstock cultivar is more tolerant of *Phytophthora* and citrus nematode infections than the rough lemon rootstock.

Collar and root rot control is improved by the combined use of nematicides and fungicides and registration of a paint method for control of the former has been sought.

A study of the role of *Fusarium solani* and *F. oxysporum* as agents of citrus decline was completed. *F. solani* was the major culprit. In the absence of stress conditions, the fungus established itself in and on the roots without causing overt damage. Where stress factors occur, the fungus switches to an active mode and causes severe root necrosis.

A range of bacteria was found in psylla as well as in greening-infected and healthy citrus. Specific monoclonals were developed against the most promising organism (*Acinetobacter lwoffii*) and the ELISA test was adapted for bacterial detection. The ELISA test shows the presence of *A. lwoffii* in some greening material from the Philippines which may imply that the bacterium is a commensal with greening.

Pests - Three chitin synthesis inhibitors show a great potential for the control of citrus psylla.

According to results obtained from laboratory rearing, the Lowveld citrus mite can complete 19 generations per year in Nelspruit, 24 in Kaalrug and 25 in the Komatipoort area.

Egg parasitoid releases can decrease false codling moth losses by 80%. This corresponds to a large extent with the control obtained with chemical sprays. Parasitoid production cost are, however, 60% less than chemical control.

Crop science - The horticultural evaluation of 71 rough lemon selections as rootstocks for Palmer navel and Olinda Valencia at Addo and Friedenheim has been finalised. A number of selections show more potential with regard to yield and quality than the standard Cairn selection and recommendations for inclusion of these selections in the Citrus Improvement Programme has been made.

A total of 1 380 citrus cultivars are presently registered in the cultivar list. Extended scion and rootstock evaluation programmes are being undertaken at six different localities and the first production data of the rootstocks at Messina has been obtained. Scion evaluation facets should be established at all the localities within the next 2 years. The evaluation of a number of early and late navels has been concluded. Although Newhall and Early Maturing were the earliest of the cultivars included in the trial, the best fruit quality was obtained with Bahianinha, Haynes, Palmer and Newhall. As a result of smaller tree size Newhall shows potential for high density plantings.

Washington navel and Marsh grape-fruit show a great deal of dwarfing with Flying Dragon as rootstock, but the yield potential is not satisfactory and it can thus not be recommended as a commercial rootstock. The evaluation of other potential dwarfing rootstocks is receiving priority. The development of models whereby the optimum spacing for various scion/rootstock combinations can be calculated has been initiated. The mechanism whereby growth and production of the scion are influenced by various rootstocks is a priority.

The evaluation of various fruit-thinning and fruit-developing agents in the Eastern Cape has almost been completed. Although the chemical manipulation of fruit size of Clementine has been successful, results are often variable, seemingly due to climatic conditions. A number of chemical agents have been tested in the Western Cape to determine the possibilities of chemical manipulation of fruit set in navels. Results are promising and the investigation has been extended to determine the relationship between endogenous hormone levels and fruit set.

Water requirements - Correct irrigation scheduling is one of the most important factors determining the size of the Valencia fruit and crop. Even during a wet season like 1987/88 when irrigation comprised only 40% of the total water used by a tree, a 26% increase in yield and 45% more large fruit was obtained with the best method of scheduling.

Pineapple

Nutrition - Soil acidification plays an important role in pineapple production in the Eastern Cape. An increase in yield of up to 10 t/ha can be obtained if lime is applied before planting to a soil containing 150 mg extractable Al/kg. Liming should, however, only be applied according to a soil analysis.

Pathology - Good results were obtained with chemical control of *Phytophthora* in pineapples. The best treatment yielded 60 t/ha, while the untreated control yielded a little over 2 t/ha of unmarketable fruit.

Pests - Mealybug infestations decreased crop yields by 12% and caused the appearance of black spot to increase by 120%. Fumigation of plants and

soil with methyl bromide, which kills several pests, increased the yield by 168 %.

It is now possible to give definite recommendations to growers for the wilting disease of pineapples. These include the fumigation of plant material with methyl bromide, the optimisation of soil fumigation and spraying techniques for upper soil pests as well as to effectively eliminate parasitic nematodes.

Avocado

Physiology - Research indicated that controlled atmosphere storage could effectively delay ripening which normally sets in during shipment to Europe, thereby allowing a better quality product to be delivered.

Calcium uptake by fruit is determined by the relative competition between new spring growth flush and the developing fruit and work is in progress to manipulate the relative fruit to leaf growth during spring to bring about a more equatable balance in favour of the fruit.

Nutrition - A highly significant relationship exists between the K, Ca and Mg status of the leaves and post-harvest physiological disorders of avocado fruit. It appears that the ratio of Ca+Mg:K in the leaves and soil gives a better indication of the possibility of physiological disorders than the actual concentration of each element.

Pathology - The project on controlling avocado diseases by the use of antagonists shows promise. Baseline studies on the avocado phylloplane have been completed. Two *Bacillus* spp. were selected as antogonists and tested in field and pack-house situations. These were as effective as standard spray schedules.

Pests - Either buprofezin (an insect growth regulator) or chlorpyrifos (an organophosphate) effectively controls the heart-shaped scale. The former should be safer for natural enemies, especially several scale types, than the wide-spectrum organophosphate.

Banana

Physiology - Direct leaf measurements indicated a large difference in transpiration rate of bananas according to diurnal and seasonal factors. Seasonally transpiration increased from 1,8 to 8,7 mm/day for winter and summer, respectively. Internal water stress was due to two causes, namely temporary wilting associated with excessive evaporative demand in summer, and the stress caused by cessation of feeder root growth in winter.

Upgrading - The third ratoon cycle of a large banana cultivar trial at Burgershall produced results which justified the decision taken after the second ratoon cycle to release the three cultivars Grand Nain, Valery and Chinese Cavendish to the local industry. Out of ten Cavendish-type cultivars, the highest cumulative yield was achieved jointly by Chinese Cavendish and Grand Nain, at 58,2 t/ha/annum. This was 10 % higher than the standard cultivar, Williams. Chinese Cavendish also had shorter and sturdier pseudostems than Williams which facilitated bunch management and greater stability.

Pests - Fumigation of soil infested with burrowing nematode with a high dosage methyl bromide together with solarisation prior to planting as well as 9 months after planting, causes a decrease in burrowing nematode numbers. Race 1 of *Meloidogyne incognita* has been found for the first time in South Africa. This root knot nematode is associated with false Panama disease.

Crop science - First ratoon results of the plant density trial at Levubu show clearly that bunch mass was reduced and crop to crop cycle time was increased as plant density increased from 1 333 to 3 333 plants/ha. Ratoon yield per annum peaked at 1 900 to 2 222 plants/ha (49 t/ha/annum) but declined severely at 3 333 plants/ha (41 t/ha/annum).

Water requirements - In the plant crop cycle at Levubu bananas yielded better with microspinner irrigation than with drip irrigation at a high crop factor of 0,8, but the opposite occurred at a low factor of 0,2.

On the Natal South Coast irrigated bananas yielded 30 % more than dryland bananas and drip-irrigated bananas yielded slightly more than microspinner-irrigated bananas in the plant crop.

Mango

Physiology - Mango storage experiments showed that in order to market fruit of good colour and taste in Europe, it is necessary to harvest at the correct stage of maturity. While fruit colour can be enhanced by post-harvest treatments, internal quality cannot.

Upgrading - The main objective of the mango breeding and selection programme is to breed and select new cultivars to replace imported cultivars which all show, to a greater or lesser extent, a lack of adaptability to South African conditions. This is particularly applicable to yield and tolerance to diseases. Valuable information as well as propagation material of five new cultivars and of promising selections were procured from Israel. Four very promising selections were identified at the Messina Horticultural Experimental Farm as well as three at Nelspruit.

Litchi

Crop science - Obtaining cultivars to extend the short 6 to 8 weeks harvesting period is a priority. The identification of promising early and late selections continues. Cultivars have been imported and promising selections from local producers have also been identified.

Granadilla

Pathology - It was found that a complex of viruses was present in *Passiflora*, comprising cucumber mosaic virus, passion-fruit woodiness virus and a further unknown potyvirus. Techniques were developed to identify these viruses.

Other subtropical crops

Tea

Physiology - The "grassy taste" encountered in many South African teas was shown to be due to a high chlorophyll level in the finished product, which is not the case with imported teas. Nitrogen fertilisation plays a role in this problem, and the maximum acceptable leaf level has been identified. Work aimed at decreasing the chlorophyll levels during tea manufacture is being undertaken.

Upgrading - CSFRI and Sapeko selections (some originated from Malawi and Kenya) were compared and the most promising selections from these comparisons will be evaluated together with the new tea clones which are available in South Africa.

Coffee

Upgrading - Eleven very promising Robusta selections have been made during the past 3 years and evaluation of cultivars will commence during the next season.

Pests - The fourth and fifth instars of Antestia stink bugs cause as much damage to the coffee beans as the male and female adults. The average number of feedings per 24 hours ranges between 4,3 and 6,5.

Crop science - The high density trials at Burgershall over the past 6 years have made it possible to make recommendations regarding the planting distances of coffee. Spacing of Arabica should be 4 200 to 6 000 plants/ha while the recommendation for Robusta is 4 200 to 5 800 plants/ha.

Ginger

Meteorology - Cooling of ginger is important to ensure optimal production and rhizome quality. During the past season, with only 161 degree hours above the critical value as compared to the long-term average of 459 degree hours, a 12 % increase in yield and 44 % increase in income/ha was obtained with impulse cooling. By using impulse cooling, 33 % more water was used per season than where no cooling was done.

Nuts

Pests - Mass rearing techniques of the green stink bug and imported egg parasitoids were developed. A sequential sampling technique of the two-spotted stink bug was developed to determine the necessity of control. Damage to macadamia nut kernels decreases as fruit size increases.

Crop science - A planting distance trial with macadamia nut trees showed that high density plantings have great economical advantages for producers. At the wider spacings a high yield per tree is achieved, but yields per hectare are lower. Higher density plantings can, however, create difficulties in orchard practices.

Evaluation of pecan cultivars is still proceeding and new cultivars from the USA were imported and evaluated under South African conditions. Evaluation for the Transvaal Middleveld reached completion, while evaluation for Western Transvaal and the Vaalharts Irrigation Scheme is still in progress.

Research showed that more than one cultivar must be planted to improve cross pollination.

Vegetables and ornamental plants

Research

As a result of the public's growing awareness of the health aspect of food, more and more agricultural chemicals are either under suspicion or, owing to pressure, simply being withdrawn from the market.

Consequently, the biological control of diseases and pests is becoming increasingly important. At the Vegetable and Ornamental Plant Research Institute attention is being given to this and to breeding for resistance against diseases particularly in tomatoes and potatoes.

It is also evident that by using biotechnological techniques, it is possible to build certain genes into plants, not only for resistance to disease, but also to manufacture agents in plants which, for example, destroy bacteria.

Flower research centres mainly around the development of improved cultivars through breeding. Specific supporting research, such as physiological studies on flowering manipulation, propagation and biotechnological techniques to overcome imcompatability, is also receiving attention.

Although the programme is continuing in co-operation with Israel to promote protea pot plants and more intensive methods of cultivation, it is not being extended. In contrast, the flowering bulb programme, particularly with the Amaryllidaceae, is receiving much more attention. The latter is being extended by co-operation with universities through contract research. The flowering bulb research programme is receiving priority mainly because of the potential in this indigenous gene bank and the fact that there is a great commercial demand for the crops as cut flowers and pot plants.

A start has been made on the investigation of other fynbos crops for possible development and refinement as commercial agricultural crops. In the meantime, growth and development studies have been carried out with *Helipterum, Rumohraadian* and *Erica* species.

Potatoes

The release of the cultivar Sandvelder and the recommended cultivar Hoëvelder may make a significant contribution towards stabilising yield and quality in the specific areas to which they are adapted.

Certain *Erwinia* spp. have been identified as organisms that cause wilting diseases which have resulted in serious damage to several production areas and problems for the certification scheme. This led to preventive measures being drawn up which limit the disease from spreading further.

The identification of calcium deficiencies as an important factor in physiological deviations in potatoes which affect quality and keeping quality meant that increased attention is given to calcium fertilisation at a research and an industry level.

The development of the improved ELISA testing procedure means that the risk linked with the distribution of seed potatoes with PVY is reduced.

Tomatoes

The line M88/71, a cross between Rodade and Stevens, is resistant to spotted wilt virus, *Fusarium* strains 1 and 2, *Verticillium* strain 1 and has a good level of resistance to bacterial wilt. It is widely adapted and performed the best in trials. The line is being considered for release to the seed industry as a parent for the breeding of F1 hybrids and should make a large contribution, particularly in areas where spotted wilt virus and bacterial wilt are serious problems.

The Institute also has advanced canning tomato lines which show resistance to root knot nematodes, bacterial wilt, *Fusarium* strains 1 and 2 and *Verticillium* strain 1. Resistance to bacterial wilt is of pacticular value to producers in the Northern Transvaal Lowveld where the disease is a problem, especially since soils already infected cannot be planted to sensitive cultivars again.

Nematode resistance is of great importance since costs can be saved on the application of nematode agents. It also offers an alternative if certain nematode agents containing bromine are banned. This affects EDB, one of the agents used most often.

Onions

The male-sterile A lines with corresponding maintenance lines will enable the seed industry to produce a variety of its own F1 hybrids. Until now it has not been able to do this because it could not breed the necessary male-sterile lines. It will be possible for undertakings to breed F1 hybrid cultivars for specific areas and thereby increase production. Less onion seed will therefore have to be imported.

Sweet potatoes

Three sweet potato breeding lines have been developed which offer significant advantages to the industry. Breeding line 85-1-2 has an improved keeping quality which can be used to great advantage to promote the rapidly developing export market. Breeding line 84-41-12 has a wider adaptation ability than the existing standard cultivars and breeding line 85-10-5 is notably suitable for freezing and can fulfill a great need in this area.

Cucurbitaceae

The pumpkin breeding lines that have been developed have a particular stem growth form, which facilitates cultivation and weed control considerably.

The musk melon cultivar Romêl, bred by the Vegetable and Ornamental Plant Research Institute, meets an important need in the production of export melons owing to the higher yield, extended keeping quality in storage and resistance to fungus infections. The release of the cultivar should promote the export of melons considerably.

The difference of opinion in the industry with regard to storage temperatures of Honeydew melons have now been settled with the confirmation of this Institute's opinion that the most suitable storage temperature is 15 °C.

Asparagus

Selected male asparagus plants can now be propagated in large quantities to obtain maximum yields of uniform, high quality asparagus. The variation in production usually found when seedlings of mixed populations of male and female plants are planted can be eliminated to a great extent.

Chicory

Even with the first generation of selections of existing breeding lines, the performance of chicory has improved to such an extent compared with the standard cultivars that the selections have improved the production of chicory in the Eastern Cape considerably.

Pot plants and cut flowers

The release of several *Lachenalia* cultivars with plant breeders' rights has led to the appointment of an overseas agent who will handle the introduction and distribution of the cultivars in Europe and the USA.

With the development of mass propagation techniques of flowering bulbs, new cultivars can now be released to the industry sooner and they can be propagated for marketing.

With the development of reliable techniques to trace *Ornithogalum* mosaic virus and to clean

infected material *in vitro*, virus-free bulbs can be supplied to the industry.

The introduction of effective fungicides for gladiolus rust can promote the successful cultivation of gladiolus cut flowers.

Proteas and fynbos

The release of the new protea cultivars can make a large contribution to improve the quality of cut flowers for the export market - on one hand because of the improved cut flower features of the cultivars and on the other hand because orderly planting leads to better production standards.

The development of inoculation techniques creates the possibility of using rootstocks that are resistant to root diseases and that are adapted to unfavourable soil conditions.

With the application of effective post-harvest pest control measures foreign markets, where proteas were once unacceptable because of insect infestation, can be exploited.

Gene bank

The gene bank of the Institute provides an indispensable service in the maintenance and release of breeder seed and foundation material to the potato, vegetable and flower industry to ensure that gene material does not degenerate genetically or phytosanitarily.

Potato gene bank - Fifty cultivars and breeding lines are maintained.

Vegetable gene bank - A total of 329 cultivars and breeding lines were collected from 25 different crops. 285 were included in the gene bank, 222 of which were described in detail.

Ornamental plant gene bank - The function of the ornamental plant gene bank is to collect and maintain a variety of indigenous species as a gene source.

Flowering bulb gene bank - The development of the fynbos and flowering bulb gene bank is progressing well and may be regarded as one of the most comprehensive collections of South African indigenous flowering bulb plants in the world.

About 8 900 flower bulbs of cultivars or breeding lines have been handled, 2 675 of which have been issued to the industry.

Protea and fynbos gene bank - More than 100 selections, ecotypes, variants and cultivars are being maintained in the gene bank. More than 1 000 cultivars have been handed over to the industry as mother material.

PLANT PROTECTION RESEARCH

Entomology

National Collection of Insects

There was a great demand for the identification of insects of economic importance. Names were supplied to other scientists and the public almost daily.

Insect surveys, with the emphasis on agricultural importance, were carried out in the Transvaal and the Cape Province and thousands of new acquisitions, together with important biological information, were thus added to the collection.

Specialised taxonomic research continued in respect of snout and leaf beetles, aphids and scale insects, Neuroptera, parasitic wasps, bees and termites. A start was made on a taxonomic study of the leafhoppers of South Africa.

Several researchers from the USA, Austria, Germany, the Republic of China, Belgium, Switzerland and Botswana visited the collection during the year.

Biological and integrated control

Stalk borers - The mass production and release of the parasitoids *Xanthopimpla stemmator* and *Tetrastichus howardi* against stalk borers in summer grain crops continued throughout the season in the Brits and Delmas districts. Several recoveries were made, but proof that the parasitoids have become established is still lacking.

Larval stalk borer populations and their indigenous natural enemies were monitored in maize and grain sorghum plots in the Brits and Delmas districts and at Cedara in Natal. Natural enemies play an important role in controlling stalk borer populations, especially towards the end of the growing season, but do not prevent economically significant damage occurring.

Moth populations of *Busseola fusca* were monitored in the Delmas and Brits districts with the aid of synthetic pheromone traps. Three peak moth flights occurred during the growing season, in mid-November, mid-February and mid-April. Omni and Delta-shaped pheromone traps were compared and evaluated. The low maintenance Omni traps were easier to handle and they caught up to four times more moths than the Delta traps during flight peaks. However, Delta traps were more efficient and sensitive in recording population changes when the numbers of moths were low.

Eight species of parasitoids and one species of predatory mite were imported and cleared through quarantine.

American bollworm - Studies on the predation of *Heliothis armigera* pupae in sorghum and maize plots near Delmas showed that predation was highest in sorghum and lowest in maize. The most important predators were mice, which were hardly present previously. To date few, if any, instances of resistance to insecticides by *H. armigera* in South Africa have been recorded.

Stored product pests - Promising results were obtained with the mass release of the indigenous parasitoid (*Apanteles* sp.) against *Ephestia cautella* in bagged stored grain. Some 40 000 parasitoids were released at a Coalbrook grain depot and the levels of control achieved compared favourably with the normal chemical control applied in depots at Greenlands and Koppies.

Honey-bee research

The evaluation of plants as a source of nectar for honey-bees continued. A total of 81 plant types were evaluated, including *Eucalyptus*, agricultural crops, weeds and garden plants, and the results were included in a manuscript on bee plants of the South-Western Cape. A *Senecio* honey which does not have the characteristic bad smell and dark colour of such honey was found for the first time. However, the plant type concerned has not yet been identified.

The analysis of 26 honey samples collected in the Orange Free State over a period of 11 years indicated the following plant types as important sources of honey: *Asparagus, Eberlanzia, Eucalyptus, Helianthus, Lycium, Onobrychis, Senecio, Walafrida* and members of the Scrophulariaceae (snapdragon family). Plants which showed promise and which may become important later are *Buddleia, Cucurbita, Diospyros, Medicago, Robinia, Schinus* and various mesembryanthemums.

In the area of pollination further research was done on sunflowers and almonds. Attempts were made to explain the problem of hollow seeds in sunflowers that occurs in some areas despite sufficient pollination. Attention was given to the possibility that hollow seeds may be caused by a lack of a trace element in the soil.

In respect of almond pollination, observations at Loskop Dam and Roodeplaat showed that this crop is unfortunately strongly influenced by competition from aloes, which blossom at the same time and lure the worker bees away from the almond blossoms. Further work is being done to solve this problem.

The revision of Departmental Bulletin No. 394, *Beekeeping in South Africa*, in both official languages has been completed.

Forest insects

Research has shown that the *Pissodes* snout beetle and diplodia play only a secondary role in top die-back in *Pinus radiata* in the Western Cape. The possibility that top die-back is related to soil fertility is being investigated.

Good progress has been made with the breeding and study of the snout beetle, *Pissodes* sp. The insect has never been bred in a laboratory in South Africa, with the result that little is known about its biology here. It has been found that the biology of the *Pissodes* beetle, which was identified as the American *Pissodes nemorensis*, differs from its American peer.

During the past year research on the pine bark beetle, which has been continuing for more than 10 years, was brought to a successful high point with the completion of three manuscripts on the ecology of this important pine pest and the creation of an integrated control programme. The key to successful control is to keep the numbers as low as possible at all times. Breeding places must be limited by means of sound forest health.

In the case of the pine bark beetle, *Hylastes*, which destroys young plantations, planting dates have to be controlled in order to avoid the peak of beetle numbers when the small trees are weak and not resistant to bark beetles. Because it is now possible to predict the time and intensity of attacks accurately, the best advantage can be obtained from selective insecticide applications.

Continued monitoring has shown that the black pine aphid and the Eucalyptus tortoise beetle are still successfully biologically controlled by natural enemies imported during the past decades. No natural enemies of the pine woolly aphid have been imported, but their numbers are spontaneously decreasing in the Southern Cape. The reason for this is probably a change in the susceptibility of the trees caused by changes in the rainfall pattern of the area and the activity of local natural enemies.

Locust research

Brown locust - During the past year additional funding allowed brown locust research to be extended. It appears that three locust generations were completed during the 1988/89 season, with 34 districts infested and some 80 000 hopper bands and 11 000 adult swarms treated.

During the year some 40 spray trials were carried out with new and promising compounds. The pyrethroids produced the best knockdown, with deltamethrin showing the most rapid action.

Some 19 spray sites at Vanwyksvlei and Putsonderwater were investigated for evidence of parasitism of the active locust stages by the flesh fly, *Wolfhartia euvittata*. Parasitism was generally low, but flies were attracted in great numbers to sprayed locust corpses.

Africa migratory locust - Generally wet conditions during the late summer of 1988/89 resulted in little carry-over of migratory locust populations, so that these insects remained scarce throughout the North-Western Orange Free State during the summer of 1989/90.

Studies on hopper survival and development under field conditions were started near Bothaville.

Economic zoology

Acarology - In the development of an integrated control programme against cotton diseases, all predators on a cotton plant are sampled. The results of the past year indicate that spiders constitute 75 % of the predator population. This finding indicates the importance of spiders as natural enemies that should enjoy a high priority in an integrated control programme.

National Collection of Arachnida - The acquisitions of mites totalled 406 and of spiders 3 200. Identifications were made for various local institutions and for institutions and persons in the Cape Verde Islands, Australia, Brazil, Thailand, the Netherlands, Zimbabwe, Namibia, Belgium and West Germany.

National Collection of Nematodes - This collection was increased by 39 to 24 768 microscope slides and now contains about 95 100 mounted

samples. During the year under review 442 soil and root samples were processed.

Species identification was done by various Departmental institutions and in respect of material originating from Martinique, Guadeloupe, French Guyana and Barbados. Taxonomic studies continued and 11 new species from South Africa were described.

South African plant-parasitic nematode survey - Surveys were made of various crops and in natural veld and the results were processed into a new data base. Of this, 650 records were loaded in the computer, which brings the number of records in the data base to 2 800. Soil analyses of 241 samples were done and processed.

Taxonomy of root-knot nematodes - A survey of lucerne fields in South Africa indicates that *Meloidogyne javanica* and *M. hapla* are common in the roots of this crop. *M. hapla* is considered an important pest of lucerne in the USA. *M. kikuyensis*, previously known only in sugar-cane in Natal, has been found on bananas in the Eastern Transvaal.

The root-knot nematode reference collection has been extended by 280 slides and now contains 3 464 slides. Furthermore, the completed guide to the identification of root-knot nematodes in South Africa has been accepted for publication.

Plant pathology

Mycology and fungal diseases

National collection of fungi - In the year under review the dried specimen collection increased to 50 547. The culture collection also continued to expand, with 373 isolates. Cultures requested by local institutions and research workers reflect a steady increase in demand. As the collection expands, it will be able to provide an even greater service.

Identification service - Identifications increased by 95 % over the previous year.

Taxonomic research - Cultures of various *Leptosphaerulina* species were obtained for a study of the ontogeny and caryology of the Loculoascomycetes. During the past year several new fungus, host and locality records were made for Coelomycete and Ascomycete in South Africa. The descriptions of a new genus and three new species have been prepared and South African literature on *Penicillium* was reviewed as a precursor to further research.

Soil-borne pathogens and root diseases - A project to study the distribution of *Phytophthora* and *Pythium* species in crops was recently initiated. Preliminary results indicate that *Phytophthora* species dominate *Pythium* in nursery soils (subtropical fruits and forestry seedlings). Pathogenic strains of *Phytophthora cinnamomi* were also found in soils recently reclaimed from virgin bush.

Pre-emergence and post-emergence damping-off by *Pythium* spp. causes substantial losses of lucerne seeds and seedlings in the Southern Cape. A study resulted in the development of a medium for the effective selective recovery of *Pythium* spp. from lucerne seedling tissue.

A considerable variation in virulence was found between 30 isolates of *Rhizoctonia solani* when tested on dry beans, soyabeans, peas and maize. Soyabeans and peas were highly susceptible to pre-emergence damping-off, but maize was virtually resistant. The high susceptibility of soyabeans to *R. solani* could have serious implications for the recent increasing area of this crop being cultivated in the Transvaal.

In a study it was confirmed that medics and wheat can act as hosts to *Fusarium avenaceum* and *F. graminearum* Gr. 1. These results have important implications for the use of medics and wheat in crop rotations.

Forest pathology - Research on *Mycosphaerella* leaf blotch of *Eucalyptus* has been concluded with the publication of a detailed study of all the *M. nubilosa* and *M. molleriana* collections filed at various herbaria around the world. Only one species, *M. molleriana*, occurs in South Africa.

Colletotrichum acutatum, Cercoseptoria pini-densiflorae, Sphaeropsis sapinea and *Dothistroma septospora* are the only potentially important pine needle pathogens in South Africa. This study has been concluded with the publication of a key to enable foresters to identify the pathogens.

During the year several diseases were reported in South Africa for the first time. They include potentially important pathogens on *Eucalyptus* leaves and an unidentified rust disease on *Eucalyptus* in Natal. This is the first report of a rust on the Myrtaceae in South Africa and because of the serious nature of rust on *Eucalyptus* in Brazil this must be regarded as a significant report.

Colletotrichum trifolii causing anthracnose of *Chamaecytisus palmensis*, a fodder tree, was also reported, as was *Verticillium dahliae*, an important soil-borne fungus causing the wilt of *Toona cilliata* trees in plantations in the Louis Trichardt area and an *Armillaria* sp. attacking *Chukrasia tabularis* trees in plantations around Tzaneen. *Armillaria* sp. was also reported for the first time in the Grabouw area, where it forms conspicuous rhizomorphs under kikuyu grass.

Bacterial diseases

At present 20 dry bean and 31 green bean cultivars are free from disease and this includes all popular cultivars. The scheme for disease-free seed has finally been taken over by the Potatoes/Dry beans/Grain sorghum Board, but the Institute's infrastructure is used while their facilities are being constructed. The increasing use of disease-free seed by farmers is reflected in the low occurrence of disease.

In addition to the more than 500 bean samples dealt with over the past year, investigations for bacterial pathogens were also carried out on more than 200 plant and seed samples of a wide variety of crops.

Biological nitrogen fixation

During the past year approximately 500 000 units of inoculant were marketed by two local manufacturers for a large variety of legumes. The increasing use of these inoculants is a result of the continuous research into better *Rhizobium* strains and the stringent quality control exercised by the Institute over the local production of inoculants.

More than 25% of the inoculants produced during the past season failed to meet standard specifications and were declared unmarketable. Commercial inoculant manufacturers, realising the value of consumer confidence and strict quality control, co-operated wholeheartedly. The Institute supplied 444 units of experimental inoculants for 57 different legumes to researchers and farmers for test purposes.

Virus diseases

Shiraz grapevine decline disease, which affects the red grapevine cultivars Shiraz, Gamay noir, Merlot and Malbec, was observed for the first time in a local grapevine planting. This disease was associated with grapevine leaf roll disease and the grapevine leaf roll-associated closterovirus Type III. These findings further support the need for an alternative control strategy based on the pre-immunisation of healthy propagation material with mild grapevine leaf roll disease strains.

A method was developed for extracting the ribonucleic acid of soyabean vein banding virus, a disease first described last year. This method can now be used in the molecular characterisation of this virus.

A method of purifying tomato spotted wilt virus from groundnuts was developed and an immunisation schedule started. Pilot surveys once again suggest that this virus is widespread and of major importance on groundnuts. An unidentified groundnut virus was also isolated during the past season and is being characterised.

Weed research

Biological control of weeds

Bugweed (*Solanum mauritianum*) - The leaf mining moths from South America have been identified as *Acrolepia xylophragma*. From the literature it appears that the moths have never been recorded as a pest on potatoes or eggplants.

An unidentified species of flea beetle, of which the adults eat small holes in the leaves and the larvae are leaf miners, was imported from South America. They are being bred in quarantine and tested for host specificity.

Satansbos (*Solanum elaeagnifolium*) - The release of two leaf-feeding beetles, *Leptinotarsa texana* and *Leptinotarsa defecta*, was withheld as they attack eggplant under cage conditions. However, they are unlikely to become pests of eggplant, as they do not attack the crop in their native USA. Furthermore, the methods whereby eggplant is cultivated in South Africa, in particular the intensive spray regimes, suggest a low probability of survival.

The fruit-galling moth, *Frumenta nephelomicta*, which proved host-specific, but failed to establish after previous releases, was reintroduced from the USA in 1989. More suitable methods of release are under investigation.

Prosopis (*Prosopis velutina* **and** *P. glandulosa*) - A second campaign was launched to have the seed-feeding beetle *Algarobius prosopis* released at as many prosopis infestations as possible. Subsequent surveys to monitor the efficiency of the beetle revealed that it has destroyed between 41 and 92% of the 1988/89 seed crop. The almost identical beetle, *Algarobius bottimeri*, was released in the Free State infestations because it is believed to be better adapted to cooler and wetter environments.

Sesbania (*Sesbania punicea*) - During the past year emphasis was placed specifically on the distribution of the stalk borer, *Neodiplogrammus quadrivittatus*, in infestations of sesbania in the summer rainfall area. This insect is particularly destructive and is well established in a number of infestations in Swartruggens, Klein Kariba, Pretoria and Hazyview.

Waterweeds - A new water hyacinth weevil, *Neochetina bruchi*, was released on *Eichhornia crassipes* on the Vaal River and Crocodile River and at Hammarsdale in Natal and all indications are that it has established.

Host specificity testing on the water hyacinth moth, *Sameodes albiguttalis*, was completed on three indigenous related plant species, namely *Eichhornia natans, Heteranthera callifolia* and *Monochoria africana*. The insect was able to feed only on *M. africana*.

Blackwood (*Acacia melanoxylon*) - Populations of the seed weevil *Melanterius acaciae* are building up slowly at various sites in the Southern Cape. The spread of the weevils away from the points of release is less than 1 km in 2 to 5 years owing to the abundance of pods. However, it has been found that in some areas trees failed to set seed in a particular year. This phenomenon may prove to be a problem in the establishment of the weevils in some areas and may hamper the biological control of *A. melanoxylon* using seed-attacking insects.

Long-leafed wattle (*Acacia longifolia*) - The seed weevil *Melanterius ventralis* is so far proving to be very effective at supplementing the gall wasp, *Trichilogaster acaciaelongifoliae*, in the reduction of seed production. The two insects together are reducing seed production by 98 to 99% of former levels. The natural spread of the weevils is slow, however, and active redistribution of these insects is therefore being planned.

Stinkbean (*Paraserianthes lophanta*) - Following insecticidal tests showing that the black wattle (*Acacia mearnsii*) seed orchards in Natal can be protected from *Melanterius servulus*, should it become necessary, permission for the release of this seedfeeding weevil was granted.

Since quarantine cultures could no longer be

maintained, the insect had to be re-imported from Western Australia in 1989. The weevils have since been released on *P. lophanta* at a few sites in the Cape Peninsula.

Hakea (*Hakea sericea*) - Evaluation of the fruit moth, *Carposina autologa*, on hakea is in its second year. At two sites in the South-Western Cape 25% and 42% of accumulated hakea fruits have now been destroyed.

Field trials over the last few years have shown that a formulation of the fungus, *Colletotrichum gloeosporioides*, can be used to control young seedlings of *H. sericea* emerging following fires. A commercially produced granular formulation of the fungus has recently been registered provisionally as a mycoherbicide.

Port Jackson willow (*Acacia saligna*) - A gall-forming rust fungus, *Uromycladium tepperianum*, first released in South Africa in 1987, has been established at about 60 sites throughout the South-Western and Southern Cape. The fungus is spreading slowly from the sites and young, heavily galled trees at several of the sites have died.

Mist flower (*Ageratina riparia*) - A leaf pathogen, *Entyloma ageratinae*, originally from Jamaica, was released on infestations of *A. riparia* around Hilton, Natal, in 1989. The pathogen has established itself and is partially defoliating the plants.

Lantana (*Lantana camara*) - A specific detoxification enzyme in insects of lantana was recently identified by means of electrophoresis. With this, it will now be possible to relate insects to specific lantana genotypes. Insects to be imported can therefore be tested for the enzyme and released on the lantana (toxic or non-toxic) to which they are best suited. Electrophoresis can also be used to identify and breed desired insect genotypes already established in South Africa. It can then be redistributed in places where suitable lantanas occur. Work in this regard has already started.

Chemical control of weeds

Paraffin/Triffid weed (*Chromolaena odorata*) - Previous trials have shown that triffid weed can easily be killed with herbicides, but that rapid reinfestation of cleared areas occurs. By overseeding/planting with grasses and implementing follow-up control measures, the severity of reinfestation is reduced and the volume of herbicide for follow-up treatments is decreased.

American bramble (*Rubus cuneifolius*) - Physical damage, the use of herbicides and combinations of these methods can be used to control American bramble growing in veld. A trial was started to determine whether representative treatments will eradicate the plant if continued for a number of years. The information leaflet was revised and describes the many treatments that can be used today.

Ecology and physiology of veld invaders

Surveys of alien invasive species - Surveys of alien invasive trees and shrubs were undertaken in the Kalahari region of the Northern Cape and in the districts of Knysna, Humansdorp, Graaff-Reinet, Willowmore and Steytlerville in the South-Eastern Cape. *Prosopis* spp. (mesquite) have formed dense infestations in the Kalahari. Many species are invasive in the Knysna and Humansdorp districts. These include species of *Acacia*, black wattle being the most widespread and abundant invader.

Black wattle (*Acacia mearnsii*) - A study of *A. mearnsii* seed dynamics has been started in different climatic regions, *viz.* the South-Western, Southern and Eastern Cape, Natal and the Transvaal Highveld. Relatively small seed banks of approximately 2 500 seeds/m^2 were found in the Transvaal Highveld, compared with the mean seed banks of 15 000 to 20 000 seeds/m^2 in the other areas. A study of seed survival in the various areas has been initiated.

Nassella tussock grass (*Stipa trichotoma*) - The evaluation of annual cold-weather grazing crops that can be established successfully on sites where nassella tussock grass has been chemically controlled has continued at Boschberg, Somerset East. Although the winter was particularly dry, Italian rye gras (*Lolium multiflorum*), woolly-pod vetch (*Vicia dasycarpa*) and assegaai or arrow-leaf clover (*Trifolium vesiculosum*) once again had the best results in the field experiments. If conditions are favourable, this fast-growing grazing crop will undoubtedly repress nassella seedlings in the environment. A pot trial at the weed laboratory at Uitenhage has shown that *Vicia dasycarpa*, which germinates at the same time as nassella, seriously represses the latter. However, the success of this crop will depend largely on favourable rains in winter and autumn.

Pesticide dynamics

Hormonal herbicides - Research in respect of the occurrence and effect of hormonal herbicides continued without interruption in Natal and the Southern Transvaal. Greater co-ordination between institutions led to improved co-operation, and overlapping of research was prevented to a large extent. Liaison with the vegetable farmers was established through the National Vegetable Committee of the SAAU.

During the past season the SA Sugar Association has tried to encourage its members to suspend the use of all hormonal herbicides voluntarily. The purpose was to determine whether vegetable cultivation in the Tala Valley would improve if there was no hormonal herbicide residue. The monitoring of rain in Natal at Dundee, the Tala Valley, Pongola, Mtunzini, Shakaskraal and Mount Edgecombe has shown a decrease in the occurrence of polluted rain samples.

No polluted rain samples could be found in the Southern Transvaal.

A high-volume air sampling apparatus was built and tested and then used to monitor air in the Tala Valley and the Southern Transvaal and during sprayings in the sugar area. Provisional results show that the apparatus works effectively and can effectively sample residue in the air during a spraying.

The sampling technique can differentiate between hormonal herbicides, such as the iso-octylester of 2,4-D and the butoxy-ethyl ester of trichlopyr and particles which contain non-volatile forms of the hormonal herbicides.

Results of trials and monitoring programmes indicate that the volatile forms of the hormonal herbicides are present in the air only for a brief period of about one day after spraying. After this, only the non-volatile forms are found, and this may possibly explain why the commonly used iso-octylester of 2,4-D, which is volatile, could not be determined in previous monitoring programmes.

A method was devised to determine all the hormonal herbicides in plant material. Although this is a long and expensive method, it does produce reliable results.

Good progress is being made with the development of an ELISA method for determining 2,4-D. A start has also been made on the development of a trichlopyr ELISA technique. A commercial 2,4-D ELISA was used with great success during the past season and it drastically reduced analysis time.

Trials were carried out to determine whether hormonal herbicides have an effect on the seed formation and the shape of tomatoes. Provisional results show that concentrations sprayed on plants at sublethal dosages can influence the shape of the fruit and the development of seed cavities.

Application technology - Existing measures for the control of water hyacinths on dams and rivers are uneconomical owing to the high volume applications (500 to 2 000 ℓ/ha). Consequently, a hand pump has been developed which has an effective spraying range over a distance of 8 m and which is mounted on a motor-boat. An optimum application volume of 150 to 200 ℓ/ha at the recommended herbicide dosage has resulted in a saving of more than 50 % in application costs.

A technique for evaluating sprayings by means of the number and size of drops reaching the target area has been developed with the aid of an image processor. At present this technique is used as the standard method in the evaluation of pesticides in field and laboratory trials.

Technical advice (Act 36 of 1947)

Some 500 applications for registration and amendments to existing registrations of agricultural remedies (insecticides, fungicides, plant growth regulants, desiccants, defoliants, rodenticides, wood preservatives, fumigants, herbicides, adjuvants, legume inoculants, algicides, repellents and attractants) have been reviewed and recommended for registration by the technical advisers of the Plant Protection Research Institute. Of these, 14 were applications for new active ingredients not previously registered in South Africa, 50 were for new formulations containing active ingredients already registered and 56 were for new claims of agricultural remedies already registered. Over 1 600 applications for registration renewals have also been attended to. There are currently 1 959 agricultural remedies registered in the Republic.

The publications *A guide to the use of Pesticides and Fungicides in the Republic of South Africa, A guide to the use of Herbicides* and *A guide to the use of Plant Growth Regulants, Defoliants and Desiccants* were revised and updated.

PLANT BIOTECHNOLOGICAL RESEARCH

Plant biotechnological research is a relatively new field of research and the activities are focused almost exclusively on supporting the conventional plant breeding programmes of the Department.

Cell biology

Anther cultures - Good results were achieved with the anther culture technique on potatoes. Anthers from the cultivar Buffelspoort were bred *in vitro* and plants were regenerated from half-developed pollen grains for the first time in South Africa. A total of 14 different clones were identified, seven of which were classified as diploid. These diploid clones can now be crossed with diploid wild potato species with the purpose of transmitting resistance to diseases to commercial cultivars.

Male asparagus plants produce a yield approximately 25 % higher than that of female plants and asparagus breeders therefore try to breed only male plants. The anther culture technique can be used to achieve this objective.

Anthers of the peach cultivars De Wet, Orion and Armking all formed callus in culture. Attempts are now being made to regenerate plants from the callus.

Embryo cultures and somatic embryogenesis - Techniques have been developed for the growing of immature embryos *in vitro* of early peaches such as De Wet and Orion and the nectarines Armking and Sunlite. More than 80 % of the embryos developed into plants and consequently these cultivars can now be used successfully as female parents in a breeding programme.

Maize plants were produced *in vitro* from immature embryos of maize. The immature embryos (14 days after pollination) were grown on artificial growth media, where they formed callus. Somatic embryos (asexual embryos) developed from the callus which were regenerated to plants. In this way a start was made on the establishment of expertise in respect of the cell biology of maize for later use in genetic construction.

Cell cultures - Cell suspension cultures were established from various crops, such as maize, tobacco, potatoes, tomatoes, Smuts finger grass and lucerne. The regeneration of plants from single cells is now being studied. Potato plants that differed from the mother plant both phenotypically and genotypically have been regenerated in this way. At present greenhouse trials are being carried out on these plants. These cell cultures were also exposed to

unfavourable environmental conditions, *viz.* high salt concentrations, in order to develop plants that show a better measure of resistance to inhibiting conditions than the mother plants.

Protoplast cultures and protoplast fusion - Protoplasts (naked cells) of various crops have already been isolated. In the case of tobacco, plants were developed from the protoplasts. At present techniques are being developed to combine protoplasts from genetically incompatible plants to transfer important properties such as cytoplasmic male sterility in this way.

Biochemistry

From investigations into stress tolerance mechanisms in maize a sifting technique was developed whereby breeders can test plants for drought resistance. At the same time another investigation showed that a specific protein is formed in maize during a drought shock. Further research will indicate whether these results can be applied in the development of drought-resistant maize cultivars.

Molecular biology

Plant diseases - Molecular biological techniques were used to find solutions for diagnostic problems in plant diseases and the creation of disease-resistant plants.

A fast, reliable technique was developed for the tracing of chrysanthemum stunt viroid (CSV) in chrysanthemums with the aid of recombinant DNA technology. A synthetic, radioactively marked probe is now available to make the diagnosis of the diseases possible.

A protein has been identified in potato tubers which could be involved in resistance to *Fusarium solani* in potatoes. This protein occurs in small quantities in susceptible cultivars such as Kimberley Choice, whereas it occurs in high levels in resistant cultivars such as Late Harvest. Furthermore, it was found that the concentration of the protein in the tubers increases as the infection progresses. The investigation will be extended to other cultivars to establish whether it can actually serve as a marker for resistance to *Fusarium solani*.

Physiological inhibition - Differences in the protein profiles of three potato cultivars during drought stress were studied with the purpose of identifying the genes involved. Drought-related proteins were observed in all the cultivars. However, Late Harvest, a tolerant cultivar, showed the greatest differences between the protein profile of control and drought-stressed plants. Efforts to isolate the genes concerned will continue.

ANIMAL PRODUCTION PROMOTION

PRODUCTION RESEARCH

Animal breeding and genetics

Blood typing

During the year under review 8 525 blood samples from cattle were received for blood typing and for the determination of certain protein types. This represents an increase of 25 % as against the previous year and is largely attributed to the compulsory typing of all herd sires for stud breeding and calves obtained from embryo transfers. Embryo transfers showed an increase of 46 %.

Population genetics

The Animal and Dairy Science Research Institute has developed a general method for evaluating herd efficiency in terms of growth and production efficiency. About the only knowledge needed for the application of this method is the allometric slope between accumulated feed-intake and body mass for an application population and the reproduction efficiency where reproduction and replacement rates, early fertility and degree of fertility at first mating are important.

Higher reproduction and lower replacement rates result in a higher proportion of crossbred progeny being available for marketing. Noticeable improvements in herd efficiency can be obtained by improving the ratio of the replacement rate to the reproduction rate.

Biochemical genetics

Genetic typing was carried out on 121 Dorper ewes from Koopmansfontein. Preparations were also made to participate in the international comparison test once again and 40 serum and blood samples from a variety of sheep breeds were received from Spain.

Genetic markers are studied as aids in the selection for important production and reproduction characteristics in pigs. Samples of various pig breeds and their crossings were analysed. Once again, a great deal of emphasis was placed on technique development in which all the systems are evaluated simultaneously. This method is cost-effective and can be applied to other farm animals.

Immunogenetics

The research on lymphocyte typing in cattle continued. A selected panel of cells was tested against serums from Scotland and Germany. Analyses of these results made it possible to plan transfers so that serums can be produced in the laboratory at Irene.

Work also continued on the development of fluorescence techniques for the determination of Class II antigens.

Cytogenetics and biotechnology

During the year under review cytogenetic investigations were carried out on 180 animals. This figure includes four sheep, 14 goats, a dog and 161 cattle. Chromosome abnormality was found in a sheep, a Nguni bull and a Bonsmara bull. The identification of carrier cattle prevents such animals from being used for breeding purposes, which is particularly important in the AI industry.

In the field of biotechnology, a positive parentage test is being developed. The test is based on the identification of very specific DNA sequences that may occur in animals. A unique DNA probe that can identify the sequences is being tested.

Good progress has been made in the field of gene mapping. Four unique DNA probes from the laboratory's gene library are being investigated on a panel of test animals.

To enable the laboratory to investigate differences between cattle breeds, the possibility of mitochondrial DNA differences is being investigated. Advanced ultra-centrifuge facilities obtained by the Animal and Dairy Science Research Institute make it possible to isolate the mitochondrial DNA. Good preparations have been obtained from heart muscle tissue. A method for obtaining the DNA from blood samples is being tested. Mitochondrial DNA studies also offer the opportunity of investigating cytoplasmic inheritance, which is of particular importance to the Institute's sheep-breeding programme.

Cattle

Resistance to ticks - A simplified method according to which cattle's resistance to ticks can be estimated by only counting all ticks under the tail and on the scrotum or udder was investigated at the Animal and Dairy Science Research Institute. Results indicate that in practice the method can be used for the evaluation of large numbers of animals. Significant differences were demonstrated between the progeny of six Nguni bulls with this method which indicates that it can be used successfully in selection for resistance to ticks.

Bonsmara - An additional Bonsmara breeding line (Wesselsvlei line) is being maintained at the Armoedsvlakte Agricultural Research Station with the aim of expanding the Bonsmara gene pool. Several bulls participate in Phase C and D tests annually with great success. The average 205-day

corrected weaning mass (1985/86 to 1988/89) of heifers and bulls was 227 kg and 247 kg, respectively. The heifers reached an average mass of 380 kg at 18 months.

A Bonsmara breeding line (the Belmont Red line) is also maintained at the Vaalharts Agricultural Research Station. The average 205-day corrected weaning mass (1985/86 to 1988/89) of bulls and heifers was 222 kg and 212 kg, respectively. The heifers reached an average mass of 388 kg at 18 months.

Milk production - The average milk production of the Elsenburg Friesland herd increased by 28 % from 5 677 kg/cow in 1984/85 to 7 278 kg/cow in 1988/89. Improved feeding practices and stricter selection for milk production of first lactation cows contributed to this to a great degree.

An extensive survey of the state of dairy farming in the Winter Rainfall Region was completed. The results for the Southern Coastal, Swartland, Boland and Little Karoo Subregions were issued in separate reports which point out problem areas.

Sheep

The Animal and Dairy Science Research Institute is still working on the establishment of a homozygous Booroola-Merino flock. A number of homozygous ewes have been identified and are being used for the breeding of homozygous rams. The average litter size is 2,39 lambs, but the survival and growth of the lambs are still unsatisfactory.

Promising results were achieved with the use of Romanov rams as a specialised lean-meat ram line in crossings with the Blackhead Persian. Provisional observations indicate that Romanov x Blackhead Persian lambs have about 80 % less subcutaneous fat than pure Blackhead Persian lambs.

Clean fleece mass - Direct and correlated responses on single-feature selection for clean fleece mass is still being investigated in the Tygerhoek-Merino flock in the Winter Rainfall Region. Direct genetic progress in clean fleece mass of two-tooth ewes has been 1,1 %/annum over the past 20 years. Correlated responses in two-tooth body mass and fibre thickness amounted to 0,93 % and 0,14 %, respectively. Selection for increased clean fleece mass therefore had a positive influence on wool production and body mass, whereas a slight increase in fibre thickness occurred.

Lamb mortality - Factors associated with lamb mortalities and lamb raising capabilities are being investigated in the Winter Rainfall Region. Observations are made on the behaviour of ewes and lambs with a view to reducing lamb mortality considerably.

The link between pelvis measurements and lamb raising capabilities of ewes is being investigated with a view to improving lamb survival. Apparatus for this investigation could be extended with the funds granted by the Wool Board.

Dorpers - A Dorper control flock (200 breeding ewes) is being maintained at the Koopmansfontein Agricultural Research Station in the Free State Region. No selection takes place. The purpose of the control flock is to monitor the genetic progress of flocks in the industry.

Karakul - Research into methods to increase the quality and usability of Karakul pelts is being given constant high priority in the Free State Region. The industry wholeheartedly welcomes the improvement of genetic breeding material in black, brown and white Karakul studs. In the breeding programme, particular attention is given to improving the most important economic characteristics of the pelts. A control flock is being maintained with the aim of quantifying genetic changes in breeding research with the Karakuls.

Management - A production system experiment at Koopmansfontein shows that overstocking (5 ha/LSU) has a negative effect on the production and reproduction of Dorper sheep. However, the highest meat production/ha/annum is obtained in the short term through heavier stocking rates.

The highest weaning mass at 100 days (29,4 kg) and also weaner lamb production/ewe/annum is obtained when the sheep lamb once a year in March/April under the recommended stocking rate (10 ha/LSU). The average mass of the ewes under the recommended stocking rates was 56,6 g, as against the 50,8 kg of the ewes under the heavy stocking rates (5 ha/LSU).

Ostriches

The effect of rest periods and seasons on the reproduction performance of ostriches is being investigated on the Oudtshoorn Experimental Farm. Egg production was very low in the breeding groups during autumn, but no direct link could be proved between egg production and any climatic factors.

A unique co-operation agreement was concluded between the Klein-Karoo-Landbou-koöperasie and the Department of Agricultural Development. In addition to financial contributions for the establishment of necessary research facilities, such as a new chick-house, it also includes the seconding of staff.

Nutrition

Livestock feeding technology

It is estimated that an annual 11 million t of maize crop residues, 2,5 million t of wheat straw and 2,5 million t of bagasse and sugar-cane tops were produced in the Republic of South Africa. The use of these and other feed sources is greatly limited by their low nutritional value. For this reason, the development and evaluation of methods to increase the nutritional value is of great importance.

By means of a new treatment in which roughage is soaked in hydrogen peroxide and sodium hydroxide for 24 hours, the digestibility of wheat straw can be increased from 40 % to 80 %. However, this process is difficult and expensive to carry out in practice and research is being done to develop a more practicable alkaline hydrogen

peroxide treatment in which less moisture and lower levels of chemicals are used. Among other things, it was found that the reaction obtained from alkaline hydrogen peroxide treatment was largely as a result of sodium hydroxide and that the additional reaction obtained from the application of hydrogen peroxide does not justify the additional costs.

The results of a feeding trial at the Animal and Dairy Science Research Institute suggested that nutrition influences carcase composition primarily through the interaction between stage of growth (live mass) and growth rate. Dietary treatments which induce a decelerating growth pattern tend to be less efficient than those with an accelerating growth pattern.

From the results of another trial it is concluded that carcase composition and grade of steers at a given carcase mass can be manipulated by means of feed intake and/or the concentrate to roughage ratio.

Rumen fermentation - Amino acids required by the ruminant can be obtained either from dietary protein undegraded in the rumen or microbial protein produced in the rumen. Microbial protein can be derived from non-protein nitrogen sources such as urea. The more microbial protein produced in the rumen, the less the need for expensive dietary protein, with significant savings in feed costs. The protein produced is, among other things, a function of microbial growth efficiency.

An experiment was conducted to study the effect of energy supply pattern on bacterial growth efficiency. From the results it was concluded that a feeding strategy which continuously supplies the highest amount of substrate to the rumen micro-organisms, but just short of a level which will result in exceeding the acid buffering capacity of the rumen, will result in the highest microbial growth efficiency.

Feed processing - Grain sorghum should be processed for effective use by beef cattle. Chemical processing is an alternative and/or an additional treatment to physical processing. At present thermal ammoniation is an economic and practicable possibility. An experiment has shown that ammoniation increased the crude protein content of low tannin grain sorghum and of high tannin grain sorghum by 28 % and 34 %, respectively, and reduced the tannin content by 23 % and 84 %, respectively.

Ammoniation in combination with a reduction of particle sizes improved the feed conversion of high tannin grain sorghum by 12,9 %, but not that of low tannin grain sorghum.

Geotrichum candidum - The fungus *Geotrichum candidum* was analysed to determine the chemical composition, energy value, protein quality, protein digestibility and amino-acid availability. It contains 53 % crude protein, 73 % of which is true protein and 9 % is nucleic acid nitrogen and it has a true metabolisable energy for poultry of 10,6 MJ/kg and a digestible energy for pigs of 11,7 MJ/kg.

The protein quality expressed in terms of relative nutritional value for rats was 48 % and the true protein digestibility was 85 %. The amino-acid availability for roosters was 85 % for lysine and 96 % for methionine. At the current raw material prices, *Geotrichum candidum* will be in demand at a price of less than R800/t.

Sunflower oilcake - Sunflower oilcake of different protein levels was analysed to establish its nutritional value. On the basis of price differences and results of feeding trials with pigs, it appears that it is not profitable to produce sunflower oilcake with a protein level higher than 40 %.

Cowpeas - The steam treatment of cowpeas increased the amino-acid availability from 74 % to 80 %. The true metabolisable energy for poultry increased from 10,8 to 11,5 MJ/kg and the digestible energy for pigs from 11,8 to 12,5 MJ/kg. Protein quality determined using rats and expressed as a relative nutritional value increased from 43 % to 51 %.

Beef cattle

Finishing - The possibilities offered by cereal and sorghum silage as finishing feeds for weaner oxen are being investigated in the Highveld Region. Bitter and, in particular, sweet sorghum silage may be used as an economic alternative to maize silage in weaner calf finishing rations, provided that at least 50 % concentrate is included in the ration.

Finishing year-old beef oxen with strategic supplementation of Smuts finger grass summer grazing is also being investigated. Concentrate supplementation, consisting of 90 % maize meal and 10 % oilcake meal, is provided since the end of January. The amount of concentrate supplementation is gradually increased every month to a maximum level of 0,75 % of the live mass of the ox. It appears that grazing substitution does not take place at this level of supplementation. The supplementation has a positive influence on the average daily increases, slaughtering percentages and grading of the oxen.

Cultivated pastures - In a study of yearling steer growth on kikuyu in the Natal Region, it was established that winter performance influenced the summer mass gains. Steers overwintered at maintenance level gained about 30 kg more on summer pasture than those overwintered to gain about 0,4 kg/day. Steers overwintered to gain 0,4 kg/day and subsequently stocked at 6 steers/ha on kikuyu achieved the highest total mass gain (202 kg) and the best carcase grades at the end of the summer grazing season.

At Dundee weaner calves were subjected to overwintering levels of maintenance and gains of 0,3 and 0,6 kg/day. During the subsequent summer the calves subjected to each of the overwintering levels were allocated to one of three stocking rates on *Digitaria eriantha* (Smuts finger grass) and *Acroceras macrum* (Nile grass) pastures. Calves wintered at maintenance gained about 20 kg more on pasture than those wintered at a gain of 0,6 kg/day. The stocking rate influenced mass gains on pasture. Calves subjected to a light stocking rate gained 60 kg (on both pastures), as opposed to gains of 37 kg on

The influence of grain sorghum in combination with different protein sources is evaluated at the Animal and Dairy Science Research Institute for slaughter lamb production

Merino sheep at Tygerhoek in the Winter Rainfall Region are selected for improving lamb survival and the mothering ability of ewes

A Persian ewe and her lamb in the Kalahari where it is essential for animals to be adapted to the unfavourable climatic conditions

Investigations at the Animal and Dairy Science Research Institute showed that beef cattle can be successfully finished by means of correctly formulated whole-maize diets

Feedlots at the Animal and Dairy Science Research Institute where the influence of divergent energy intakes on growth, carcase composition and efficiency at a constant slaughtering mass are investigated

Nile grass and 47 kg on Smuts finger grass at a heavy stocking rate.

Overwintering - Different ratios of sheep and cattle on maize residues were compared at Dundee in the Natal Region. Preliminary results indicate that maize residues are beter utilised when grazed by sheep and cattle, than when either sheep or cattle graze alone. Weathering of the residues occurred fairly rapidly, indicating the need to use the residues as soon as possible after harvesting.

Phosphorus supplementation - The effect of phosphorus supplementation on the production and reproduction of beef cows is being investigated at Armoedsvlakte, Koopmansfontein and Vaalharts in the Free State Region. At Armoedsvlakte reproduction is influenced by both the level of phosphorus supplementation and whether it is administered over a period of 6 or 12 months. Provisional information at Koopmansfontein indicates a possible lack of phosphorus. At Vaalharts there is no sign of a lack of phosphorus in cows or their calves at this stage.

Dairy cattle

Concentrate feeding - From a study carried out in the Free State Region it is clear that frequent concentrate feeding cannot simply be recommended for lactating cows which receive less than 60% concentrate. However, the production possibilities and use of good quality roughage deserve attention first.

Whole maize - At Dohne in the Eastern Cape Region, the efficiency of milk production was investigated with whole maize in complete rations for dairy cows. Caustic soda treatment of maize was applied as an alternative. Although feed intake and milk production was higher on the meal diet, the efficiency of feed consumption was 5% higher with whole maize. The caustic soda treatment of maize meal had a positive reaction and increased the efficiency of feed consumption by 13%. Despite the cost of caustic soda, this treatment produced the highest feed margin. Feed margins tend to favour whole maize if milling costs exceed R20/t.

Sheep

Finishing - Wheat straw was evaluated in the Winter Rainfall Region as a roughage component in the finishing diets of weaners. Lucerne hay was gradually replaced by wheat straw, lupin and fish-meal. As the wheat straw increased, the intake and average daily growth increase was negatively influenced. However, the feed conversion efficiency was not affected. Rations with up to 26% wheat straw may be used successfully. Thermal ammoniation of the wheat straw did not have any advantage over the untreated wheat straw.

Cultivated pastures - The potential of kikuyu pasture for growing wethers was evaluated at Cedara. Average daily gains decreased from 110 to 25 g as the stocking rate increased from 22 to 55 wethers/ha. At light stocking rates the grazing system exerted little influence on animal performance. However, rotational grazing yielded better animal performance than continuous grazing at a heavy stocking rate. Maximum production of live mass/ha was achieved at a stocking rate of 35 wethers/ha.

Irrigated Italian ryegrass is widely used to overwinter ewes in Natal. A trial at Cedara aims at determining whether pasture availability or a lack of energy or protein limits the performance of suckling lambs on ryegrass. Control (unsupplemented) lambs gained 99 g/day on ryegrass, as against 150 g when supplemented with energy, 178 g/day with protein, 228 g/day with a combination of energy and protein and 119 g/day when lambs were allowed to forward graze the ryegrass.

The effect of nitrogen fertilisation level on animal performance is also receiving attention at Cedara. The study showed that adapted animals can tolerate relatively high levels of plant protein and nitrate nitrogen.

Angora goats

Energy requirements - An experiment in the Karoo Region to determine the energy requirements of Angora goats shows that their maintenance requirements do not differ from those of other goats. The energy requirements for growth and raw hair production are estimated at 31,9 and 136,8 kJ/g, respectively. Although not necessarily physiologically interpretable, these values are nevertheless an indication that hair production on a mass basis requires more energy than growth. This result may be explained by the fact that several observations in the literature indicate that hair production is regulated hormonally and that it is accompanied by changes in the intermediary metabolism. This is a matter which will have to be investigated further in selection for increased hair production.

Pigs

Barley - The use of barley instead of maize has great financial advantages for pig producers in the Western Cape. Growth and carcase studies in the Winter Rainfall Region showed that as much as R25 000/150-sow unit could be saved per annum on a barley-based diet.

The shortage and high price of animal protein forces pig producers to use locally produced plant protein sources. For this purpose, faba beans and sweet lupin are being evaluated in growth and carcase studies in the Winter Rainfall Region.

Protein metabolism

In vivo studies on the digestion in the small intestine of sheep have been based on estimating the disappearance of protein between the duodenum and the ileum, by using sheep with cannulae in the duodenum and ileum. In order to reduce the technical difficulties that limit the application of this

and related techniques, it was decided at the Animal and Dairy Science Research Institute to investigate an approach whereby the large intestine is bypassed, allowing ileal digesta to be directly collected.

Other aspects of protein digestion which have been examined with the aid of this model include the true digestibility of feed, the uptake of amino-acids from the small intestine and their transport into the mesenteric circulation, and the extent of nitrogen recycling between the large intestine and the rumen.

Intermediate metabolism

The wool growth rate of SA Mutton Merinos on a basal diet of wheat straw was increased by 226% with cottonseed meal oilcake at 200 g/day and by 96% with maize (200 g/day). The advantage of higher growth rates was, however, offset by an increase in fibre diameter - 26% with cottonseed and 6% with maize. Supplementation with 100 g maize/day appeared to give the most economical results under current price structures.

Lambs receiving a low-fibre diet had a 27% better growth rate and a significantly improved feed conversion ratio against a high-fibre diet. It is suggested that feeding a low-fibre diet improves the efficiency of utilisation of digestible energy by altering the partitioning of nutrients in the body.

Animal physiology and meat science

Meat quality

Packaging - Various packaging systems are being evaluated at the Animal and Dairy Science Research Institute for application in a centralised packaging system for retail cuts of pork. The best results were obtained with individually wrapped PVC packs which were packed together in a vacuum bag in a carbon dioxide atmosphere. According to the total number of microbes, this packaging may be stored for 21 days and then still displayed on the shelf for an extended period of 4 days. Other packagings had a retail shelf life of up to 14 days.

Pork - At the Animal and Dairy Science Research Institute an evaluation was done on belly bacons and chops from carcases of SA Landrace and Large White crossbred boars, gilts and barrows slaughtered at four mass groups. Hot boar bacon odour and texture were less acceptable than that of gilts and barrows. The general appearance and flavour of bacon made from 68 and 87 kg slaughter mass groups appeared to be the best. Hot boar chop fat and meat odour, tenderness, flavour and general acceptability were also less acceptable than that of gilts and barrows. Chops from 53 and 68 kg slaughter mass groups were the most juicy.

Results of findings on meat quality characteristics as influenced by genotype, slaughter mass and sex are currently being used for the establishment of a new pork-carcase grading system aimed at satisfying the needs of both the consumer and the processing industry in respect of the description of the pork carcase. Meat quality characteristics in crossbred pigs are also being investigated. Results in this regard should enable producers to approach crossbreeding more objectively in respect of the needs of the market.

Pig stress syndrome - Findings show that blood variables and muscle metabolites cannot be used in identifying stress-sensitive and -resistant pigs at a young age. The halothane test still appears to be the most reliable method of identifying such pigs, although it cannot indicate the carriers.

Stress-sensitive pigs showed a lower feed conversion ratio, a higher slaughtering percentage, a lower refrigeration loss and a thinner fat layer than the resistant pigs. However, the stress-sensitive pigs showed pale, soft and watery meat throughout, in other words, generally poorer quality meat.

From results of experiments it is further evident that the stress-sensitive pigs react differently to physical stress and to the stress caused by the narcotic halothane. The differences require further study to give better insight into the problem.

Refrigeration - An investigation has shown that refrigeration and cooking temperatures have an important effect on meat quality characteristics. The present general cold storage temperatures used in South Africa have a negative effect on meat quality. Problems accompanying chill shrinkage should also receive attention. At present it appears that electric stimulation of cattle and sheep carcases is the best way of combating the negative effect of chill shrinkage.

Livestock and livestock product improvement

Milk production - The Animal and Dairy Science Research Institute conducted an investigation to determine to what extent milk production, milk composition and feed intake of Friesland cows is influenced by the administration of bovine somatotrophine (BST).

Milk production increased by an average 23%, while total feed intake increased by 13%. Milk composition remained constant.

Meat production - The potential of anabolic growth promotants for intensive lamb production was investigated at the Animal and Dairy Science Research Institute. The aim of this study was to determine the effect of certain estrogenic and androgenic growth promotants, mainly used for intensive beef production, on mutton production under feedlot conditions. Results showed that, with the aim of producing the optimum carcase grade, animals implanted with certain growth promotants can be fed more economically and to higher slaughter masses compared with non-implanted animals.

Wool production - In a woolled sheep reproduction study in an intensive production system it was shown that the Finnish Landrace reaches sexual maturity sooner than the other woolled sheep breeds used in the trial. In the first year the whole group of 26 Finnish Landrace ewes reached puberty at an average age of 219 days. In contrast, only 12

out of 24 Booroola-Merinos, eight out of 24 Merinos and five out of 22 SA Mutton Merino ewes reached puberty at this age. The oestrus lengths of the Finnish Landrace were noticeably longer and the cycle lengths were shorter in comparison with the other three breeds. The ovulation rates of the Finnish Landrace ewes and Booroola-Merinos were considerably higher than those of the Merinos and SA Mutton Merinos.

Dairy science

Dairy chemistry

During the past year attention was given to the polymorphism of milk proteins in various dairy herds. The milk of 328 cows was analysed quantitatively and both Friesland and Jersey herds were typed in respect of their lactoglobulin.

In the project dealing with the influence of milk products on blood cholesterol levels and atherosclerosis in general, it was shown that there is not much difference between the blood cholesterol values in rats that received butter and margarine, respectively, as a diet.

Dairy microbiology

Research concerning the microbiology of milk and dairy products centres around the growth and survival of micro-organisms during the manufacture and storage of dairy products, and the influence of micro-organisms on product quality and keeping quality. With this, purposeful investigations were launched into the microbiology of certain ecosystems in which bacterial biofilms play a role in the recontamination of milk. It was found that several psychrotrophes contain contaminant biofilm-causing properties. In favourable conditions these organisms can coat poorly cleaned milk pipeline surfaces and multiply and in this way negatively influence the quality and shelf life of pasteurised milk and dairy products.

The long-chain fatty acid composition as a technique to identify lactic streptococci in South African commercial starter cultures is being investigated. Genetic studies on group N streptococci have also been carried out. It was found that by manipulating the genetic composition of starter cultures, excellent starters can be obtained which may reduce possible problems in the manufacture of cheese.

Dairy technology

Several *ad hoc* studies were carried out for dairy organisations. Various products were subjected to ultrafiltration and then powdered, and rennet enzymes were tested for the manufacture of cheese. The economic use of ultrafiltration techniques in the manufacture of cottage cheese to establish increased protein content is being investigated. So far the results have indicated that cottage cheese made according to this technique produced higher yields.

The hydrolysis of lactose for use in dairy and other products is also being studied. The price of the enzyme involved in the process has increased drastically, but it has been established that it can be reclaimed successfully and reused up to nine times with an activity of 98 %.

Milk science and technology

Extension programmes have made an important contribution to the improvement of the chemical and microbiological quality of milk produced in the Western Cape.

Every month the milk-recording laboratory analysed an average of 36 386 individual cow samples from 361 herds for fat protein and lactose content. A further 40 herd samples were analysed for fat and protein content during the same period for purchasing purposes.

Dairy training

This Section, which has its headquarters at the Glen Agricultural College, has presented various courses for the dairy industry during the past year. A great deal of time was spent on practical work to ensure that, in addition to sufficient theoretical knowledge, the candidates also have enough skills to be absorbed into the industry.

Industry development

The Section is involved in activities in a number of areas. They varied from guidance to primary and secondary dairy producers to demonstrations and lectures and the development of dairy products, research, the analysis of dairy export products and the issuing of export certificates.

A large number of raw milk samples were analysed bacteriologically. High counts of bacteria were mainly a result of dirty milking machines and dairy equipment. The analyses also indicated that, with a few exceptions, the microbiological quality of yoghurt, cottage cheese, ice-cream and butter was excellent.

Water samples were analysed bacteriologically for both primary and secondary dairy producers. The bacteriological quality of borehole water from primary milk producers was sometimes questionable.

A pathogen laboratory was also established for testing for *Listeria* and specifically for *Listeria monocytogens*, which can occur in milk, dairy products, vegetables and meat, among other things.

Poultry science

Breeding research

Outstanding results have been achieved during the past 2 years. In the industry an annual gain of 40 to

50 g in mass increase of broilers is expected. In the grandparent lines at Irene, an annual gain of between 80 and 100 g was observed. At the same time, egg production also increased.

The demand for breeding material continues unabated. During the past year 12 700 day-old chicks, 3 800 breeding hens and 7 700 day-old ducklings were sold to farmers. Smaller numbers of turkeys, guinea fowl and quails were also delivered to breeders.

As in previous years the Animal and Dairy Science Research Institute was able to make an important contribution to the provision of fertilised eggs for the preparation of human and animal vaccines by the virology and veterinary science institute.

Nutrition

Research to compare the nutritional value of different sunflower oilcake meals continued. No differences were noted in body mass, feed intake or efficiency of feed conversion.

The effect of vitamin D_3 and manganese on the bio-availability of phosphorus in broilers was determined.

Waterfowl research

Ducks fed on a feed restriction regime were subjected to a forced moult at 60 weeks of age. The forced moult caused the ducks to lose an average of 16 % of their body mass and most of their feathers. However, 6 weeks after the beginning of the forced moult, the ducks were again in production and, although not as high as during the first 40 weeks, production was nevertheless high enough to be of economic importance. For example, it takes a duck 24 weeks from hatching to come into production, whereas it takes only 6 weeks after being subjected to a forced moult to do so.

Ducklings were also able to thrive on diets containing 40 % unrefined sugar as an energy source, showing that when a surplus of sugar occurs it can successfully be used as a feed source for monogastric animals.

Performance and progeny testing

Beef Cattle Performance and Progeny Testing Scheme

Beef cattle have been subjected to performance testing since 1959 in order to exploit variation meaningfully in respect of the various economically important features. The results serve as an aid in the selection process.

Since the Scheme was established, its membership has extended to the present 1 798 that represents 1 971 herds. The same breeder may enter a stud and a commercial herd in the Scheme.

A total of 273 000 mass determinations were carried out under Phases A and B of the Scheme during the past year, and 10 759 bulls were subjected to Phases C and D growth tests. This is the largest number of young bulls ever to be tested in a year and it is 291 more than in the previous year.

In the growth tests of bulls, attention is given to reproduction and conformation features. In this way, weak bulls are eliminated and a positive influence is exercised on the beef cattle industry.

The progeny of six bulls used for AI were subjected to carcase evaluation. The results show significant differences in carcase quality features among the bulls.

National Woolled Sheep Performance and Progeny Testing Scheme

The constant growth of about 15 %/annum in respect of participation in the National Woolled Sheep Performance and Progeny Testing Scheme was maintained during the year. The total number of 73 253 wool sample analyses at the SA Fleece Testing Centre represents a rise of 9,5 % above that of the previous year.

The growth in the Scheme may be attributed largely to the so-called micron madness that the textile industry is currently experiencing and which has apparently taken root throughout South Africa. The price differential in favour of fine wool is still maintained.

The Fleece Testing Centre was designed for the analysis of about 60 000 wool samples per annum. When capacity was exceeded, the facilities and staff structure had to be upgraded. Delays in respect of analyses should therefore be eliminated within the foreseeable future.

Dairy cattle performance and progeny testing

At present an average of 1 762 herds and 119 100 cows are tested in terms of this scheme every month. This is an increase of 63,1 % and 98,5 % for herds and cows, respectively, over the past 10 years. The average milk production has increased in this period by 20,2 % from 4 252 to 5 122 kg.

Together with the control tests, 1,46 million tests were carried out to determine milk mass and butterfat, protein and lactose values. The number of young bulls nominated for the progeny testing programme was 477, of which 256 were selected and 66 purchased by the AI industry.

About 31 771 first lactation records for bull evaluation were approved. A total of 5 214 bulls were analysed by means of the BLUP method. This places the official bull analysis in the RSA on the same level as that of the leading dairy-producing countries in the world. The results of 614 bulls qualified for publication.

National Mutton Sheep and Goat Performance Testing Scheme

During the year under review data from 70 552 lambs were processed, as against 90 062 the previous year. Phase D1 and D2 tests on rams are still popular and 3 810 rams were included in these tests during 1989/90.

National Pig Performance and Progeny Testing Scheme

The existing scheme is being phased out this year and at the same time the new Pig Improvement Scheme will be introduced.

The new Pig Improvement Scheme - The objectives of the National Pig Performance and Progeny Testing Scheme are to introduce performance testing to the industry, to identify animals that have the genetic potential to improve the national herd, to identify boars with good merits for AI purposes and to ensure that pig breeding practices and related production systems keep up with the market requirements of the future.

The Scheme incorporates only those stud herds belonging to breeding companies or breeders of pure-bred pigs. From each herd 100 boars per breed are tested on the farm annually, and representative samples of 40 pigs are tested centrally. These herds are all members of the Pig Health Scheme of the Meat Board.

On-the-farm testing - Pure-bred boars from the stud herds are tested on the farm in respect of growth rate and growth efficiency of 27 to 86 kg live mass and at the end of the test, backfat thickness is measured ultrasonically.

The performance of each boar is expressed as a deviation from the average performance of its contemporaries in the herd. The information is analysed by the Department and set out in an index which gives each boar a breeding value mark. At this stage this index mark is simply an indication of a boar's genetic value relative to all other boars in the herd.

Central testing - To be able to compare the genetic potential of boars from different herds, every stud breeder sends 20 young sows and 20 boars to the local testing centre every year where performance can be identified under identical environmental conditions. When the tests are finished, the pigs are slaughtered and a thorough carcase evaluation is carried out.

The results of the centrally tested pigs are used to determine a herd merit mark which is included in the final index mark for each farm-tested boar. Boars from a herd that performed well on the central test will get a higher index mark, whereas boars from below-average herds will lose marks.

The improvement in growth performance and meat on the carcase that can be achieved by the use of high-index boars increases the profitability of the producer and of the industry in general.

Random sample poultry test

The 1989 broiler test was well represented and supported by the broiler industry. The direct result of genetic advance is that the slaughtering age is reduced by about one day per annum. At present commercial broilers are slaughtered at 42 days old.

The egg production test was, however, very successful and an average egg production per hen per day of 281,1 eggs was recorded. The highest production was 291,3. There were two important imports of laying hen genetic material owing to the results of the past 2 years' tests. This had a fundamental impact on the whole laying hen industry.

VETERINARY RESEARCH

Vaccine production and development

The consumption of vaccines decreased by 21,4 million doses during the year. A total of 149,4 million doses of vaccine were sold by the Veterinary Research Institute. The bacterial vaccines of which sales were down were those for pulpy kidney, botulism and quarter-evil. The disturbing decrease in sales of anthrax vaccine still continued. The sales of this vaccine have decreased since 1981 from 19,5 million doses to 11,8 million this year.

The virus vaccines of which sales were less than last year are those for bluetongue, inactivated Rift Valley fever and Wesselsbron disease. This decrease is also cause for concern because if good rain seasons were to continue, there is the danger that an epidemic could break out owing to the susceptibility of the animal population, and result in serious losses. The lumpy-skin disease of the past season is a striking example: 4,5 million doses were sold, compared with 0,5 million per annum in previous years.

The main problem is that the vaccine plant at Onderstepoort is under great pressure and does not have the capacity to be able to supply enough vaccine in a short period.

At present the replacement of the vaccine plant's outdated working equipment is receiving top priority. A protein extraction facility was started with which the plant can prepare its own peptones. These peptones are the first step in the preparation of new combination vaccines for which there has been a need for a long time. A fully automatic fermentor facility will also be installed, with which certain bacterial vaccines can be produced more cost effectively.

Viral diseases

Although good rains fell over most parts of the country, no wide-spread occurrence of traditionally insect-transmitted viral diseases was observed. However, the occurrence of horse-sickness and equine encephalitis in the Boland was extraordinary, since the diseases are usually limited to the Transvaal Lowveld, the northern parts of Natal and, in more favourable years, also the Transvaal Highveld.

During the past year 4 061 serological tests were carried out for 18 different viruses, 1 038 samples were investigated for rabies and 653 samples were handled for virus isolation and/or identification. The samples for virus isolation increased by more than 30 %.

The samples that were tested also include samples from seven African states. Reagents for diagnostic tests were supplied to two regional laboratories, five African states and three European countries.

Bovine malignant catarrh

The epidemiological study of bovine malignant catarrh was completed. The findings agree with the generally accepted view that the bovine malignant catarrh virus which is excreted in the eye moisture and nasal mucus of wildebeest calves in autumn is the source of infection for cattle when wildebeest calves are 4 to 5 months old. Bovine malignant catarrh does occur in autumn in South Africa, but it occurs mainly in the spring when wildebeest calves are 8 to 10 months old and have not excreted the virus for months already.

Contrary to what is generally accepted, close contact between cattle and wildebeest is not a prerequisite for the transmission of the disease. In the spring the occurrence of bovine malignant catarrh in cattle in camps adjacent to wildebeest is even higher than in cattle together with wildebeest. However, as the distance from wildebeest increases, the occurrence of the disease reduces.

The high occurrence of bovine malignant catarrh in the spring, when wildebeest excrete very little virus, and the fact that close contact is not a prerequisite for transmission, possibly indicates biological transmission. However, there is no example of a herpes virus that is transmitted biologically.

Nevertheless, the possibility will be investigated when usable techniques for such a study have been developed.

Cattle-to-cattle transmission of bovine malignant catarrh occurs in cows in calf with bovine malignant catarrh, when their calves can become infected before birth.

Bovine malignant catarrh virus DNA was characterised by restriction enzyme analysis and various fragments were multiplied in a suitable vector. The recombinant clones are now subjected to tests to establish their usability in tracing the virus.

Polyacrylamide gel electrophoresis with silver colouring appeared to be an effective method of indicating rotavirus and reovirus in faecal samples. The technique is just as good as or better than electron microscopy; it can be done within 8 hours and it can distinguish clearly between the two viruses even when mixed infections occur. Under the electron microscope the two viruses were not morphologically distinguishable.

Biochemistry

A group of closely related orbiviruses, *viz.* bluetongue (BTV), horse-sickness (AHSV), equine encephalitis (EEV) and epizootic haemorrhagic disease (EHDV), is being studied on a molecular level. Each of these viruses has a large number of serotypes. For example, in the case of bluetongue there are 24. The aim is, among other things, to develop new vaccines with better production and usage features and to develop new methods of diagnosing the various virus infections. A large number of genes of the viruses concerned have already been cloned.

During the past year it was established that the NS1 gene of the bluetongue virus and of EHDV can register very small quantities of infectious virus particles after only 24 to 48 hours of infection of tissue culture. This is at least five times faster than the existing virological methods used.

In horse-sickness the NS2 gene can indicate the presence of the virus in, for example, gnats, mosquitoes and splenic fibre, but in this case the sensitivity is still too low to be practicable.

However, a very sensitive ELISA test has been developed for the diagnosis of horse-sickness virus and it has been used successfully in both local and foreign outbreaks. It is specific and also sensitive enough to trace the virus in insects, splenic fibre and tissue culture.

Monoclonal antibodies were prepared against horse-sickness virus.

The homopolymer particles that must be attached to orbivirus genes during the cloning process to make cloning possible mean that the genes are not suitable as subunit vaccines without further ado. However, a significant breakthrough was made in that an easy method has been found to remove the homopolymer particles without damaging the cloned genes themselves. Three genes which code for different structural proteins of the bluetongue virus and the NS1 gene of EHDV have been dealt with in this way and can now be cloned and evaluated as subunit vaccines.

The use of cattle retrovirus as a vaccine against jaagsiekte in sheep is being investigated and although it is a long-term project, good progress is being made.

A good start was also made on the project to develop the vaccine strain of lumpy-skin disease virus as a vector for recombinant subunit vaccines.

Foot-and-mouth disease

Sequence determination of part of the 1D gene of foot-and-mouth disease virus and neutralising monoclonal antibodies applied to SAT-2 type isolates obtained from three southern African outbreaks of the disease (in impala in the Kruger National Park and in cattle in Zimbabwe and Namibia) facilitated the first molecular epidemiological investigations into foot-and-mouth disease in the subregion. These investigations showed that the outbreaks in South Africa, Namibia and Zimbabwe were caused by very different viruses and were therefore not related. It was also found that viruses circulated in wildlife in these countries formed distinct sub-populations readily identifiable by RNA sequencing.

Together with the World Reference Laboratory for Foot-and-mouth Disease, an investigation into the origins and inter-relationships between the viruses involved in the catastrophic outbreaks in Zimbabwe in 1989 was undertaken. As a result of this joint investigation a report has been drawn up for the European Foot-and-mouth Disease Commission.

Subtyping of viruses SAT-1, SAT-2 and SAT-3 recovered from buffalo in the Kruger National Park showed that their relationship with vaccine strains was poor, indicating that current vaccine strains would not be expected to provide protection against most viruses unless cattle had been vaccinated repeatedly. For this reason extensive testing of recent SAT-1 and SAT-2 isolates has been undertaken in an attempt to produce more appropriate vaccine strains.

Transmission experiments with domestic goats and wildebeest were completed. The finding reported last year that goats failed to transmit infection to susceptible cattle in close contact, despite significant viral excretion, was confirmed. The vaccination policy with respect to goats in endemic areas in South Africa should therefore be reconsidered. The wildebeest experiments showed that these animals, at least with the two virus strains so far tested, are both relatively resistant to infection and, once infected, excrete little virus. It could therefore be concluded that they are not normally involved in the epidemiology of foot-and-mouth disease.

Investigations into the ultrafiltration of vaccine antigen and storage over liquid nitrogen were completed. As a result the concentration and storage processes are being changed, which will result in antigen with an indefinite shelf-life. This will save hundreds of thousands of rand annually since expired vaccine will no longer have to be thrown away. It will also enable the Institute eventually to store antigens appropriate to different regions of the subcontinent and produce "tailor-made" vaccine.

Investigations into the possible implementation of a fermentor system for foot-and-mouth disease vaccine production, possibly in parallel with inactivated rabies vaccine, were initiated.

Protozoal diseases

Babesiosis

Cattle - Further evaluation of a frozen monovalent redwater vaccine is producing satisfactory results. The extended viability of the vaccine makes it possible for the vaccine to be available continuously, even in remote places. However, the viability of this vaccine is considerably shorter than expected. Too slow cooling of the vaccine after bottling appears to be a problem.

So far the red-legged tick *Rhipicephalus evertsi* has not been confirmed as a vector of *Babesia bigemina.*

Horses - Promising results were obtained with the *in vitro* cultivation of *Babesia equi.* The immuneblot identifies several immunodominant proteins of *B. equi* that can be used in an ELISA test. Investigations into the vectors of *B. equi* and *B. caballi* are still continuing. A sensitive and specific DNA probe has been developed which is able to indicate *B. equi* infection in horses accurately.

Theileriosis

Good progress has been made with the refining and standardisation of *in vitro* culturing techniques for *Theileria* spp. What is also significant is that successful tick transference can occur from animals that have not received specific treatment, which indicates that corridor disease can sustain itself in cattle in the absence of buffaloes through *Rhipicephalus zambeziensis.*

Anaplasmosis

A freeze-dried trial vaccine was evaluated under conditions that imitate its transportation and distribution in practice. It appears that the vaccine offers definite advantages over the frozen vaccine in respect of lower transport and storage costs.

Heartwater

The doxycycline implantation, which is used at the same time as the existing sheep blood vaccine, is now commercially available. Although the method cannot be recommended for the immunisation of Angora goats without reservation, it is being used relatively successfully in sheep and cattle in the veld.

The continued use of the fluorescent antibody test in the study of the epidemiology of heartwater at the Mara Research Station has shown that the seropositiveness of calves and young animals is a very true reflection of the rate at which the animals are infected by ticks. It may help to determine with greater certainty what the tick count on the cattle in the herd (and therefore the dipping frequency) must be to ensure that young calves are infected when they still have enough natural resistance.

Constant progress is being made with the purification of the heartwater organism from endothelium cell cultures. The purification of whole living organisms is particularly promising. Similarly, the identification of the 27 and 31 kDa *Cowdria* proteins, which are common to nine strains of *C. ruminantium,* also holds promise.

Molecular biology

In research attention is being given to molecular aspects of certain rickettsial and protozoan parasites. These include *Anaplasma centrale, A. marginale, A. ovis, Cowdria ruminantium, Babesia equi* and *B. caballi.*

The Anaplasma- specific probes were mapped and a repetitive sequence was identified on one of them. The repetitive sequence responsible for the specificity of the *Babesia equi* probes has also been identified. The probes have been found to be able to monitor the course of an infection with *B. equi* in an experimentally infected horse and a positive identification could be made as early as day 3 post-infection.

Bacterial and reproductive diseases

A new *Escherichia coli* serotype occurred in poultry during the year, causing airsacculitis in chickens. It was identified in samples originating from all parts of the Republic and was the most common pathogenic serotype present in chickens.

Corynebacterium (*Actinomyces*) *pyogenes* was responsible for heavy losses owing to abscessation and pneumonia in ruminants. It has become far more predominant in sheep than *Corynebacterium pseudotuberculosis* (*ovis*).

Actinobacillus pleuropneumoniae has now been isolated from 32 farms in the Republic, where 10 of the

12 recognised serotypes occur. This organism usually causes chronic pneumonia and pleuritis in pigs.

In the research into and development of a live, avirulent *Salmonella typhimurium* vaccine, it was decided that the vaccine strain should carry a marker for easy differentiation from other similar strains. A *Salmonella typhimurium* was chemically treated to give auxotrophic colonies. A number of strains were identified which lost their virulence plasmids. These strains could be differentiated from other similar *Salmonella* strains by their auxotrophic character and also the absence of their plasmids. An *in vitro* test was also developed to determine virulence.

The degree to which Johne's disease has spread in the Republic is difficult to estimate as no easy and reliable serological methods are available to distinguish subclinically affected animals from healthy stock.

Brucella abortus accounted for 6,35 % abortions in cattle, therefore remaining one of the most important causes of abortion. *B. abortus* was also isolated from the milk of 8,33 % cows examined. *B. melitensis* was isolated for the first time in over 20 years from an aborted caprine foetus and from a slaughtered pregnant doe in the same herd.

Trichomonas foetus was found in 13,16 % of the bulls and 30,95 % of the herds tested. The same samples yielded *Campylobacter foetus* in 5,0 % of the bulls and 15,48 % of the herds. Of these, 3,03 % of the bulls and 13,1 % of the herds had dual infections. The new medium for the isolation of *Trichomonas* has significantly improved the diagnostic efficiency of the laboratory.

Entomology

Ticks

The serology of three breeds of cattle exposed continuously from a young age to tick infestation under non-dip conditions showed very high levels of immunity to up to four tick-borne disease organisms over a 2-year period. By contrast, cattle that were constantly dipped remained highly susceptible to infection. This and other results strengthen the argument for minimising chemical control. The transition from intensive to extensive control regimes, however, remains a problem for which research must supply adequate answers.

Midges

Research on *Culicoides* biting midges made a number of significant steps forward. Although bluetongue disease is common in the Eastern Free State the only proven vector, *C. imicola,* was rare, but replaced by a closely related species, *C. bolitinos,* which breeds in cow dung. The role of *C. bolitinos* and cattle in the transmission cycle of bluetongue in this Region should be investigated.

The investigation of a bluetongue outbreak at Alma in the Waterberg confirmed the results of earlier surveys at Stellenbosch and Onderstepoort which indicate that man-made irrigated pastures create ideal breeding places for *C. imicola.* This midge species was extremely common in the Waterberg on farms with irrigated pastures, but scarce elsewhere in this predominantly ranching area.

In the Kruger National Park a number of midge species, of the same subgenus to which *C. imicola* belongs, were collected behind the ears of culled elephant and made up most of the light trap collections at the culling sites. This is very good evidence that the dispersal of these midges correlates strongly with the dispersal patterns of their hosts.

In the study of the morphology of the pupal stage of *Culicoides* many new characters have been found which can be used to differentiate between species, the adults of which are sometimes extremely difficult to separate. The pupal stage has adaptations which allow it to survive in totally different environments from those of its adult stage. For example, the respiratory horns of the pupa of a species which breeds in rhino and zebra dung were found to differ radically in structure from the respiratory horns of a similar species which breeds in the much wetter dung of buffalo and cattle.

Studies on African horse-sickness (AHS) have proved that the virus can multiply in the suspected vector, *C. imicola.*

The survey of the distribution of AHS in South Africa, using sera collected from donkeys, is half completed, with 2 800 donkeys in 156 magisterial districts having been bled. Although large areas still remain to be sampled, the results so far indicate that antibodies to AHS were present in 50 to 60 % of the sera from the Transvaal and Natal, and in 9 % of those from the Free State and the Cape. Positive sera from the Karoo and Western Cape suggest that AHS is more widespread than was suspected.

Conical flukes

An investigation on a farm in the Witbank area showed that effective control of the conical fluke is possible if all the animals are treated.

On one farm with almost ideal conditions for the maintenance of the parasite all the cattle and sheep were treated against it effectively. On an adjacent farm with similar conditions only the young animals were treated during an outbreak of the disease. No further control measures were applied.

Over a period of 2 years infected freshwater snails (the intermediate hosts of the parasite) were virtually absent from the farm where all the animals were treated first, whereas on the other farm infected snails were found almost constantly when the pans contained water.

A few freshwater snails from a group that were collected during an outbreak of conical fluke near Pretoria survived for 7 months in the laboratory, and produced a maximum of 471 fluke larvae per snail per day.

Long-term storage of roundworm larvae

After a period of almost 16 years of frozen storage in liquid nitrogen 82 % of the larvae of eight types of sheep roundworm were still alive and 25 % were still infectious to their hosts. It has now been found that larvae sometimes need a recovery period of a few hours after defrosting before they become fully mobile.

Before they are put into frozen storage larvae are exsheathed, otherwise survival is poor. Despite the general expectation that the larvae would survive for only a short period after defrosting, it was found that certain groups of wireworm larvae survived for 3 weeks after defrosting almost as well as unfrozen control larvae with sheaths. Furthermore the infectiousness was almost as strong as that of the control group.

Toxicology

During the past year 1 665 specimens from 685 outbreaks of poisoning were analysed. This represents a reduction of 11 % in the number of specimens received and 13 % in the number of outbreaks investigated. This slight drop in diagnostic activity could probably be attributed to an increase in tariffs that came into effect in 1989. The number of positive diagnoses rose from 29 % to 31 %.

Geeldikkop

One of the most notable findings related to the aetiology of the major ovine photosensitivity disease, geeldikkop. In both geeldikkop and *Panicum* photosensitivity, the photodynamic agent phylloerythrin is retained as a result of the occlusion of bile ducts by birefringent crystalloid material. The factors responsible for the formation of these occlusive microliths are contained in the plants.

Following reports from abroad that two similar ovine photosensitisations, namely "alveld" in Scandinavia and *Agave lecheguilla* poisoning in the USA, had been reproduced by dosing sheep with crude saponins from the plants, the possible role of these substances in the aetiology of geeldikkop was re-evaluated. As a result, geeldikkop has now been experimentally produced by administering crude saponins from *Tribulus terrestris* to sheep at the Veterinary Research Institute.

Geeldikkop is the last of the great epidemic diseases of Southern Africa of which the aetiology has not been fully elucidated. Since Theiler showed in 1918 that *T. terrestris* was responsible for geeldikkop, no time or effort has been spared to isolate the elusive toxic principle of the plant. Identification of crude saponins as the causal agent of geeldikkop must therefore rate as one of the most important toxicological findings in South Africa in 70 years.

Diplodia

A previous report that *Diplodia maydis* caused severe perinatal mortalities of lambs has been confirmed. Dosing trials involving 66 ewes revealed that 60 % of the lambs of ewes exposed to *D. maydis* cultures in the second trimester of pregnancy and 87 % of those of ewes exposed in the third trimester were either stillborn or died soon after birth. No such losses were recorded in the offspring of ewes drenched during the first trimester. A disturbing feature of the trial was that the lambs of ewes that had not shown clinical signs of diplodiosis and those of ewes that had shown such signs were equally affected.

Fumonisin

The identification of the mycotoxin fumonisin B1 as causative agent for equine leukoencephalo-malacia has opened the prospect of developing an assay for the toxicity of horse feeds and for the chemical diagnosis of the condition.

Food and milk hygiene

Research was continued on aspects of milk and feed hygiene. As far as mastitis control is concerned, and consistent with efforts at improving herd udder health, further work is continuing to modernise the present technique for the inter-laboratory standardisation of somatic cell counting in milk. Various other aspects related to udder condition and health are also receiving attention. The computer-supported laboratory diagnosis of mastitis has lead to a programme which reduces by approximately 60 % the time usually required by the laboratory to process the large number of milk samples collected during a herd examination.

Investigations on the effect of heat stress in dairy cattle produced extensive data which have facilitated the zoning of temperature-humidity index values and related prophylactic management measures.

Ketone bodies in milk suggest that fluctuations in these bodies may be related to aspects of management and metabolism, with possible implications for udder health of dairy cattle.

Work on the chilling of springbok carcases suggested that carcases of better meat and microbiological quality can be produced under field conditions by means of a chilling process more economic than that generally used at present.

Information management

Computer centre

The programme for the diagnostic service of the Institute has made good progress. It includes a link to a computer network, and the development of a geographic information centre on the distribution of insects and diseases is foreseen in the future.

Technical advice to the Registrar: Act 36 of 1947

During the period under review the technical advisors of the Institute dealt with a total of 742 applications for the registration of stock remedies. Of these, 108 were new applications and the rest were amendments to or renewals of registrations. A total of 361 advertisements were checked for scientific accuracy.

Work is still being done on a book which lists all registered stock remedies. Computerised lists of these remedies are available on request.

AGRICULTURAL RESOURCE DEVELOPMENT

RESOURCE RESEARCH

Land type surveys

The Soil and Irrigation Research Institute has prepared two new land type maps for publication and a further two are in the final preparation stages. The twelfth memoir in the Institute's series on the natural agricultural resources of South Africa was published and another three volumes are being prepared for publication.

Other surveys

Peri-urban surveys - The semi-detailed soil surveys in the Pretoria-Witwatersrand-Vaal Triangle complex have been completed and the information is used extensively by regional and town planners. The information forms an important basis in negotiations when non-agricultural bodies lay claim to high-potential agricultural land.

Soil surveys and investigations for irrigation - A reconnaissance survey was completed on 170 000 ha in the Designated Area next to the Limpopo River and its tributaries. Detailed and semi-detailed surveys were carried out on 41 600 ha of parts of the Pongola, Orange, Riet and Lower Fish River catchment areas.

Soil fertility

The effective use of nitrogen by plants is being investigated in co-operation with the Republic of China. A computer model was developed whereby the conversion of soil nitrogen can be predicted in laboratory incubation studies.

An international crop production simulation model was used to predict crop yield and the nitrogen uptake of maize at Heidelberg and wheat and soya beans at Roodeplaat.

In pot trials it was proved that nitrate nitrogen is used more effectively by plants than ammonia nitrogen.

According to fertiliser consumption statistics, the application of sulphur has declined drastically during the past decade and sulphur depletion in the soil is already to be observed. The situation is being monitored in order to be able to make timeous corrective recommendations.

Soil physics

Work continued on the physical characterisation of the plough layer state and behaviour. Advanced techniques and parameters new to soil science were used to characterise tillage surface microtopography.

The effect of gilgai on crop yields was tested and the crater "syndrome" investigated, but the relationship to gilgai mounds could not be defined.

It was established that differential clay weathering owing to a slope effect (bedrock contour) causes the red-black soil genesis in the Northern Transvaal and not petrography as previously proposed.

Soil mineralogy

An investigation into the recrystallisation of monocalcium phosphate showed that these phosphates are sensitive to high humidity and absorb crystalline water which makes the determination of water content during routine analyses difficult. It was also established that drying temperatures should not exceed 80 °C because crystalline water and structural water are expelled at over 80 °C.

Black and red Arcadia soils were compared and an increase in red colour indicates an increase in the kaolinite content. Iron and aluminium are transferred from the crystal structure of clay minerals without a change in the crystal structure and they precipitate as goethite and hematite, which give the red colour to the soil.

Soil chemistry

A handbook on standard methods of soil analysis was compiled for advisory purposes and is distributed under the aegis of the Soil Science Association of South Africa.

Water research

Methods of improving the soil surface were investigated further in field and laboratory research. The water infiltration ability of various types of soil is improved by preventing soil surface sealing. The most effective treatment thus far is the surface application of an organic polymer with gypsum. The gypsum flocculates the soil surface and the organic polymer binds the clay particles and gives stability against the destructive action of drops of water. A significantly higher wheat yield has already been produced with an experimental irrigation system on gypsum-and-polymer treated soils. In addition to improved water infiltration, erosion is limited to a large degree.

The use of effluent water for irrigation was investigated. Many enquiries are made in this connection. A start was also made on research into the effect of waste products on the pollution of soil.

Soil-plant-atmosphere-water relationships

The wheat yield and grain quality depend on the water status of wheat during the growing season. The Roodeplaat model was developed to estimate the leaf water potential of wheat with the ground-water status and weather variables as parameters. The leaf water potential is then used to estimate the plant's irrigation requirements.

Computer models are systematically being developed to be more user friendly because they can be

used for farm management. Growth and development of crops are important parameters in crop models, but information in this regard is often not at the farmer's disposal. For example, most farmers do not have the leaf area index. Results from an investigation with grain sorghum as the test crop proved that plant height, measured from the soil surface to the highest leaf point, is directly proportional to the leaf area index across a wide range of moisture-inhibiting conditions. Plant height can easily be measured by the farmer and in this way replace the leaf area index in models to measure crop performance during the season.

Agricultural meteorology

A computer model for the simulation of interception of direct solar radiation, taking into account row direction, plant density, row width and growth stage, was designed for maize. Light interception together with water available to plants are used to forecast the inhibition at any time in the active growing season of maize.

The monthly average duration of sunlight in the Winter Rainfall Region was charted and quantified. This information is summarised with the other weather elements, such as temperature and evaporation, in the Region's geographical information system.

The involvement of agricultural meteorology in research on vineyards and deciduous fruit was expanded and the effect of weather conditions on vineyard diseases and of trellis growth on radiation interception is being investigated. The effect of wind on apple yield and of weather conditions on the rate at which the apples ripen is also being investigated.

Remote sensing

Two research facets were completed, namely the development of a technique for soil classification which, in some areas, can reduce soil survey time by more than 20 % and a veld condition identification technique using satellite imagery. This technique has greatly assisted the demarcation of veld condition in the Bloemfontein area and has a potential survey time saving of more than 50 % in some areas.

Good progress was made with the collection of field data for a veld mapping project with a view to the development of a broad-based veld monitoring technique on a national scale. A report is in preparation of the first phase of the drought monitoring project using meteorological data. DECILE monthly and yearly maps at the 1 to 4 000 000 scale are being prepared for publication.

REGIONAL DEVELOPMENT

Highveld Region

Resource classification - A report was compiled for land use planning in the relatively homogeneous farming areas of the Lichtenburg subregion. A total of 25 dominant crop and veld ecotopes were identified and defined. A potential grazing capacity was calculated for each veld ecotope by using the computer package on grassland dynamics for the Highveld parts of the western grassland biome. It is the intention to compile similar reports for all the subregions in the Highveld.

Attention is also being given to the creation of an agricultural resources information system.

Production risk - The production risks for maize, grain sorghum and sunflower are calculated on the dominant crop ecotopes in the RHFAs of the Highveld Region. Detailed rainfall data for the Region have been collected and the possibility of introducing production costs of crops into this risk analysis is being investigated.

Land conversion scheme - In the Highveld Region 2 640 applications for conversion have already been received for 233 039 ha. Pastures have already been established on 91 915 ha of this. During the past year alone 1 357 applications were received for 118 600 ha and almost 50 000 ha of pastures have been established.

Other uses of agricultural land - During the year 64 applications for the subdivision and consolidation of agricultural land were dealt with, as against 74 last year. A total of 55 applications for change of use of agricultural land were also finalised and 36 road inspections were carried out.

Resource conservation - During the past year 1 385 soil conservation works were approved in the Highveld Region, which is a drop of 45 % as against last year. However, 2 400 works were completed, as against 1 300 last year. The drought of the past number of years has had a depressive effect on the erection of soil conservation works, particularly in the western parts of the Region.

The total subsidy payments in respect of soil conservation works amounted to R1,05 million. The subsidy payments on direct conservation works, *viz.* runoff channels and contours, amounted to 83,5 % of the total and only 17 % in respect of watering points and fences. The fact that soil conservation works are subsidised at 75 % and fences and watering points at only 25 % is probably the reason why farmers erect less inner camp fences and stock watering works. The cost of materials for fences and watering points has increased considerably during the past year.

Karoo Region

Geographical information system - During the year a geographical information system for the Region was put into operation and is being used in whole-farm planning, among other things, to obtain more technically correct planning.

Resource classification - Attention is being given to the refining of the existing RHFAs. Approximately 5 million ha were involved in this during the past year. About 1 000 ha were described in respect of soil potential with a view to irrigation suitability and crop production.

Farming models - Decision-making models were developed in respect of stock type combination selection and camp grouping. These systems will be further refined. Models in respect of veld control are in the pipeline.

Drought-resistant crops - Investigations were carried out into the preferences of Dorper sheep for three saltbushes, *viz.* old-man saltbush (*Atriplex nummularia*), Mediterranean saltbush (*A. halimus*) and fourwing saltbush (*A. canescens*). It was found that the sheep select a high fibre content and discriminate against the saltbushes on the basis of the combined high

sodium and potassium content. The preferences were 52 % for fourwing saltbush, 41 % for old-man saltbush and 7 % for Mediterranean saltbush.

Natal Region

Farming trends - Late rains and continuous wet weather during December followed by dry spells during January and February resulted in a reduced maize crop. Maize plantings continued to decrease, with substantial increases in the areas under soya beans and dry beans and areas planted to pastures.

Favourable price structures during the past year have resulted in the further expansion of the red meat industry. Increased interest is being shown in fodder flow planning, with pastures playing an increased role in supplementing the veld.

The unprecedented expansion in timber production, mainly in the cold high-rainfall areas, is continuing. During the past year 122 applications for the establishing of 40 830 ha of timber were inspected. The effect of this expansion on the water supplies of the Region remains a matter of great concern.

High interest rates and unstable markets have dealt the pineapple industry in Northern Zululand a severe blow. More than half of the approximately 45 growers were forced to terminate their pineapple farming operations.

Land conversion scheme - During the past year 141 farmers, involving 10 771 ha of land, have applied for participation in the soil conversion scheme, with 2 928 ha being established to pastures. Some 75 % of the applicants participating in the scheme farm in the maize growing areas in Northern Natal. Of the 7 945 ha of pastures established, 62 % has been planted to Smuts finger grass.

Soil conservation - The research programme aimed at establishing conservation norms for the most important crops grown in Natal has been expanded to include maize under four different tillage systems, and to measure soil and water loss from soya beans, dry beans, sunflowers and tobacco.

Land preparation norms for the establishment of timber were compiled and accepted by the timber industry. Minimum standards for laying out tobacco fields were devised and are being tested for general use.

Runoff control planning for erosion control was carried out on 5 000 ha of cultivated land on the Pongola irrigation settlement.

Analytical and advisory services - The analytical and advisory services offered by the Natal Region play a very important role in determining fertiliser requirements on most farms. The computerised fertiliser advisory system for use on a personal computer was further developed. Recommendations are presented in a more acceptable form and the programme makes provision for monitoring changes in the fertility patterns throughout Natal.

The demand for soil and plant analyses continues to increase. Soil fertility analyses were done on 20 608 soil samples and 3 252 plant samples were analysed. The soil physics laboratory analysed 2 948 samples.

Floods - Exceptionally heavy rains of up to 500 mm in 7 days during November 1989 caused extensive damage in the Magudu and Pongola areas, and to the flood control works and infrastructure on the flood plains of the Umfolosi flats planted to sugar.

Loss of agricultural land - Owing to the unprecedented expansion of township development a total of 6 678 ha of land, much of which is high potential agricultural land, has been lost to agriculture.

Eastern Cape Region

Survey - Intensive surveys for soil conservation and production planning purposes were carried out on 46 farms covering 10 080 ha of land. A total of 143 vegetation survey transects, covering four veld types (Valley Bushveld, Dohne Sourveld, False Thornveld and Eastern Province Thornveld), were carried out. Approximately 47 % of the information pertaining to the above work was required for research purposes and the remaining 53 % was for use by the extension service to persuade farmers to adopt improved methods of veld management.

Irrigation planning - A total of 112 farm visits were undertaken in connection with irrigation design, systems evaluation and scheduling advice. For this purpose soil surveys covering 1 000 ha of land were carried out.

Soil conservation - A further decrease was again experienced this year in the number of works approved and completed under the subsidy scheme. A total of 934 works with a subsidy value of R506 000 were approved, which represents a substantial reduction as against the previous year, whereas 609 works with a subsidy value of R177 684 were erected - a decrease of 5 % against the previous year. The tendency is that more attention is given to the erection of smaller works for which the financial expenditure of the farmer is less.

Since the early 1970s there has been a definite downward trend in the number of works approved and completed. This can be attributed largely to the fact that the subsidy tariffs during the past years have not kept up with rising costs.

A start was made on wind erosion trials on the Bathurst experimental farm. Various wind-breaks with different spacings are being investigated.

New extensions - In the Elliot ward a start was made on large-scale plantings of trees by a private paper undertaking. Approximately 120 farms with an area of about 75 000 ha were purchased and plantings have already begun.

Transvaal Region

Farming trends and problems - Cattle prices and prices of weaners dropped at the end of the summer in the Bushveld area. There is concern that overproduction with consequently low prices may result, which will not be financially beneficial to farmers.

The area under irrigation in the Bushveld decreased because of the deterioration of water resources and the low levels of irrigation dams. The cultivation of dryland cash crops decreased drastically. There was a significant increase in the establishment of cultivated pasture. The shortage of labour and the high input costs are also causing concern. Throughout the whole Region farmers

are under increasing pressure from high interest rates and rising costs.

On the Lowveld the tendency to plant large areas to mangoes is still continuing. Owing to good prices and demand for macadamia nuts large expansions are also expected in this industry. The good prices during the past two seasons have made farmers consider ginger once more.

As during last year the cultivation of dryland winter wheat on the Springbok Flats decreased. The reason for the decrease is mainly problems with crater disease, on which there is little information, and economic considerations.

In the North-Western Transvaal it is mainly tobacco and cotton production that are being affected negatively by the unfavourable conditions. By contrast, there is increasing interest in cultivated pastures on which sheep, in particular, can be kept.

In the Limpopo area the results of long droughts and poor farming conditions are becoming increasingly clear in the socio-economic situation of the farming community. The rate of insolvencies of irrigation farmers, in particular, is rising.

In the South-Eastern Transvaal the rising production costs have further weakened the financial position of the majority of the farmers. Money for expansion and for changes in farming practices is not available.

Paprika was cultivated with great success in the Ohrigstad area. Expansions in respect of the coming season amount to almost 400 %. However, there are still large deficiencies with regard to the cultivation of suitable and the most profitable winter crops. With regard to the stock factor in Ohrigstad, there were expansions mainly in respect of sheep farming, particularly where farmers let the sheep graze on the vegetable crop residues.

In the Brondal and Malelane areas wilt in guavas assumed serious proportions. It could destroy the industry completely in the foreseeable future. New outbreaks of the disease were also observed in Hoedspruit and Levubu.

Resource centre - Good progress has been made with the implementation of a geographical information system. A complete data base has been completed for the Limpopo subregion.

The system was also used for the national food and fibre production plan, and in an urgent investigation on the Springbok Flats it was possible to produce climate maps very quickly. A computer programme that arranges soil type inventories into soil suitability classes greatly accelerated and facilitated the evaluation of the soils of the Springbok Flats and those of the high-recovery coal-mining areas.

Soil conservation - The poor financial position of farmers, too small farms and a degree of negativeness towards soil conservation make the promotion of conservation difficult. The low subsidy tariffs and out-of-season rain made a large contribution in respect of the reduction in the number of works completed this year. The conservation situation in the Bushveld and on the Highveld is not as it should be and more inputs will have to be made on the Government's part to improve the situation.

Free State Region

Ecotopes - A provisional demarcation of crop ecotopes along with a handbook was completed. The document was supplied to extension officers and researchers, among others, and has already resulted in more purposeful research in the Northern Cape and the Central Free State.

A start was also made on the demarcation of veld ecotopes. It will not be possible to use the new geographical information system effectively at farm level if there are no well-described ecotopes with production and yield data bases.

Stock production - A diagnostic computer programme has been developed with regard to wool, mutton sheep and beef cattle production for farmers who keep insufficient records. The programme is being tested and will be made available to extension officers. At the same time production and yield records will be made available.

Bush control - This scheme appears to be a great success. Outstanding results have already been achieved and as the considerable improvement in grazing becomes noticeable, there is a tendency in the farming community to accelerate bush control. Since the previous year there has been an increase of 64 % in the area where invader bush has been controlled under the subsidy scheme. Burning as a control method is used less and less and shows a decrease of 68 %, whereas chemical control shows an increase of 24 %. A new service by which companies provide chemical agents and also apply them by hand at a nominal fee, is gaining ground.

The increase in the cost of burning and chemical control as plant density increases should be taken into account in the subsidisation of the scheme. A tariff for light, medium or heavy infestation appears to be desirable.

Farm planning - There was an increase in the number of farm plannings during the past year after there was a sharp decrease the previous year, mainly because of the priority given to the completion of the flood relief scheme. However, insufficient subsidy tariffs had a restricting effect on the progress with farm planning.

As the Kalahari East water supply scheme progresses, the demand for plannings from farmers wanting technical and financial help on distribution networks is expected to increase accordingly.

Soil conservation - During the past year a subsidy amount of R2,7 million was paid out in respect of soil conservation works.

On the whole there was a large increase in subsidy payouts on conservation works - an increase of 156 %. This is due mainly to the increase in completed drainage systems and also to the bush control scheme. The contribution of drainage systems was mainly a result of the completion of a number of large schemes in the Douglas area and cannot be regarded as a trend.

In the light of serious soil losses occurring in crop lands in the Southern and Central Free State Regions and the eastern parts of the Griqualand West Subregion, the small area protected by contour walls during the past year is cause for concern.

In the overall view it is clear that the inadequacy of the subsidy scheme has a great influence on the progress

in mechanical protection measures. Many farmers are just not in a financial position to supplement the ever-increasing contributions out of their own pocket.

However, on the other hand there is also concern about the attitude towards conservation of a part of the farming community. Mechanical works are often doomed to failure if they are not supported by conservation-directed cultivation and tillage practices.

Flood relief scheme - Under the flood relief scheme works with a subsidy value of just more than R1 million were completed during the past year. Compared with the approvals granted, a large percentage of flood-damaged works have not yet been repaired.

Winter Rainfall Region

Soil investigations - During the year under review several soil investigations were carried out in support of advice about the establishment of vineyards and fruit orchards, in particular. Numerous enquiries are also received for advice in respect of the establishment of grazing crops. During the past year 2 288 profiles were described on 3 600 ha and it is clear that soil investigations hold considerable value for producers.

Land use guide-lines - The land use guide-lines for 30 different long-term crops for the 79 farming areas in the Winter Rainfall Region were finalised and published.

Soil classification project - A start was made on an extensive soil classification and charting project whereby all arable agricultural land in the Winter Rainfall Region is investigated intensively. Soil investigations will be carried out per farm and all information will be loaded into the soil data bank of the resource information system.

Soil science - During the past 2 years there was an investigation into the lodging of wheat, which was relatively common in the Malmesbury-Riebeek area. It was established that no disease organism was involved in the situation, but that susceptibility to lodging is apparently increased when sowing takes place early on brackish soil and where there is higher sowing density and nitrogen fertilisation. In soil analyses the zinc and boron content were found to be low.

It is a known fact that the quality of malting barley is affected negatively by high uptakes of nitrogen. In an investigation on 10 typical barley producing soils it was found that their ability to release nitrogen varied from 5 % to 11 % of the soil's total nitrogen. It was also found that the weekly mineralisation rate of soil nitrogen amounted to about 4,9 % of the potential.

Fertilisation of faba beans - The faba bean is being cultivated more and more as a forage crop in rotation with wheat in the Winter Rainfall Region. From fertilisation trials so far it appears that the crop, similar to lucerne and medics, prefers a soil pH of about 5,5. In contrast to most cash crops, faba can apparently use rock phosphate just as well as superphosphate.

Advisory services - During the past year 144 000 analyses were made for advisory purposes for 2 027 producers on 8 055 soil, 6 188 plant and 233 water samples. The analyses represent an increase of 21 % as against the previous year and reflect mainly greater use of leaf analyses by fruit producers and trace element analyses of soil by producers of grain, pastures and cash crops.

Soil conservation - Soil conservation works with a subsidy value of R2 429 891 were surveyed and approved, and works with a subsidy value of R1 072 301 were completed. The subsidy value of proposed works was 3 % lower than the previous year, when the highest amount ever was involved. However, in the completed works there was a decrease of 19 % in the subsidy value.

The decrease can be attributed mainly to a shortage of technicians, insufficient subsidy tariffs, difficult economic times for farmers and a lack of skilled contractors to erect the works.

There is still a demand for drainage works. This indicates that, in spite of unfavourable circumstances, farmers in the intensive irrigation areas realise the necessity of effective drainage.

Weed control - Nassella is still being eradicated in the areas in which it occurs in the Winter Rainfall Region. Scotch thistle, spiny cocklebur and large cocklebur are also widespread and sometimes create problems. Sesbania was largely eradicated in the urban areas, in particular, but there are still many town dwellers who are unaware that it is a declared weed. In places it still grows thickly along the Berg and the Olifants River. On the whole the sesbania snout beetle has eaten most of the flowers so that no further distribution occurs, but it appears that the numbers of beetles have decreased in some areas.

Oleander has encroached in just a few areas along rivers, but it may cause problems later.

Light infestations of water hyacinth, water yarrow and water fern were found in some areas in rivers, but in places dams were completely infested, which causes waterspouts to become blocked and the water quality to decline.

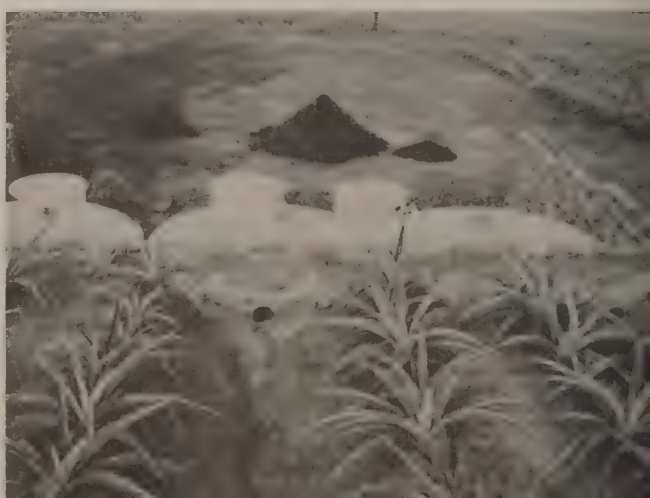
Advanced soil erosion on former lands in the southern part of the Ceres-Karoo in the Winter Rainfall Region

In the drier areas of the Winter Rainfall Region saltbush appears to be a valuable supplement to veld grazing. On the photo ewes and their lambs are grazing saltbush plantings in the Ladismith ward

An example of a well-protected and maintained water-way in the Agter-Paarl-Perdeberg area in the Winter Rainfall Region

A start was made in the Eastern Cape Region with wind erosion trials on the Bathurst experimental farm where different windbreaks with different spacings are being investigated. The photo shows windbreaks on chicory lands

A demonstration to show how soil losses can be restricted on pineapple lands in the Eastern Cape Region



DEVELOPMENT OF ENTREPRENEURS

PROGRAMMED EXTENSION

Highveld Region

At the end of the year under review there were 50 active study groups with 729 members involved in programmed extension in the Highveld Region. The members of one study group make up about 5 % of the 16 300 farmers in the Highveld Region. Most of the study groups are involved in cropping and pasturage.

Three soil classification courses and three pasture courses were held, as were several farmers' days, information days and farmers' tours.

There are several demonstrations, the results of which serve to confirm and support the extension message.

Programmed extension emphasises the whole-farm approach in which farm planning is based on the available resources and production practices are adapted to them. Great emphasis is placed on the learning process and persuasion so that the farmer can eventually help himself.

The main problem experienced by farmers was the rapidly decreasing profit margin of many of the farm enterprises. In spite of the good rains during the year many farmers experienced a shortage of operating capital as a result of the higher inputs that were needed. The continued rise in input costs, particularly in respect of cash crop cultivation, caused serious set-backs for many farms. More and more farmers, especially younger farmers, are experiencing financial problems.

There is a general spirit of pessimism among farmers, which causes a negative feeling towards their industry and towards extension. A shortage of the necessary trained agricultural extension officers in the Highveld Region is also hindering the whole extension programme.

Excellent progress is still being made with the withdrawal of marginal soils and the conversion to perennial cultivated pasture, and the inclusion of stock farming is receiving more attention. Interest, particularly in respect of sheep, is increasing.

Karoo Region

The conservation committees in the Karoo Region are active and in most cases fulfil an important role in motivating fellow-farmers towards a positive awareness of conservation and in cultivating the right attitude. Most committees base their activities on an annual programme drawn up in advance, of which field days and visits to farms in order to inspect veld and to exchange ideas and results are regarded as some of the most important.

In the North-Western Karoo the 18 pasture study groups with 274 members held 72 meetings at which training was given in knowledge of the veld and veld management. The results of the inputs of groups can be seen clearly in the implementation of veld management systems. The general experience is that the attitude of farmers towards the veld and the soil is improving.

The nine conservation committees in the Great Karoo serve as an excellent link with the Department and enjoy a high degree of credibility among fellow-farmers. As a result of the close contact that committee members have with their fellow-farmers, several cases of misuse of farms have been identified and these cases could be influenced by extension.

Progress with the establishment of drought fodder crops is slow throughout the area. A shortage of irrigation water during establishment, the poor utilisation of crops and high establishment costs are some of the reasons.

The financial position of farmers in the Fish River irrigation area is not as it should be. High input costs and high interest rates can be regarded as the most important causes of the situation.

The main aim of the irrigation study group in the Fish River Valley was to acquire knowledge of irrigation and crops. By means of scheduling the members of the study group succeeded in increasing the efficiency of their water consumption by about 20 %. The Mortimer study group succeeded in developing an improved marketing strategy for lucerne with the local agricultural co-operative.

Irrigation farmers below the P.K. le Roux Dam and Orange-Fish Tunnel also experienced financial crises and even bankruptcy.

Natal Region

In order to establish, objectively, the research and extension needs as perceived by the farmers, ten technical liaison committees, consisting of farmers and representatives of agricultural organisations, have been established in co-operation with Natal Agricultural Union, to deal with the most important enterprises in the major ecological areas of the Region. To promote the aims of the National Grazing Strategy 27 one-day veld courses were held throughout the Region. During the year some 21 farmer groups were involved with this programme. The courses *inter alia* included such aspects as principles of planning, stereoscopic photo planning, species identification and veld condition assessment.

An intensive cultivated pasture programme for the promotion of pastures to meet the full fodder requirements of beef, sheep and dairy enterprises has resulted in a complete change of the fodder production on 28 farms. This has resulted in considerable economic benefits to the farmers.

During the year particular emphasis was placed on pasture management and alternate crops to

maize. A one-day programme, repeated on two consecutive days, dealing with pasture and animal research being conducted on Cedara attracted approximately 2 500 farmers.

The latest research findings on the cultivation of maize, soya beans and dry beans were presented at two farmers days at the Dundee and the Kokstad Research Stations and were attended by 380 farmers.

Eastern Cape Region

Crop farmers in this Region had serious financial problems because of the erratic rainfall of the past few years, marginal soils and input costs which have sky-rocketed. In the Algoa Region extension gave a great deal of attention to promoting stock farming by establishing lands to permanent pasture. The land conversion scheme made a big contribution to progress in this regard. The stocking rate on the veld also decreased considerably because of the effect of the droughts.

The drought conditions and the critical position of the crop farmers led to good progress being made with two facets in the Elands River and Humansdorp areas to encourage stock farming on cultivated pastures. Pastures were established on old grain lands and marginal soils. In the Humansdorp ward perennial pasture was planted on 11 000 ha, which promoted dairy farming, among other things.

In the Aliwal North extension ward the future is regarded with a lesser degree of optimism. The high interest rates and input costs accompanied by lower product prices of wool, mohair and meat had a depressing effect on the farming community. Attention will have to be given to the creation of the necessary infrastructure, such as camps and stock watering points, to be able to apply effective veld management systems. From surveys it appears that the stocking rate is within limits for the most part.

In the Border Subregion 105 veld condition reference points have been made. As a result of extension inputs farmers are generally veld-conscious.

In the Elliot extension ward attention is being given to improved stock production through better use of the natural grazing and the stabilisation of winter feed flow by using cultivated pasture. There is interest in the establishment of cultivated pastures. The average increase of 15 % in wool production and 21 % in meat production is considerably more than the objective that was set.

Transvaal Region

During the year under review a great deal of progress was made with various extension programmes and 20 new facets were registered, among other things.

In the Limpopo and the Northern Transvaal Subregions there are 12 active study groups with a total membership of 145. There are four conservation committees in the area and the Thabazimbi and Ellisras committees are very active and play an important role in conveying the extension message.

In the Central Transvaal Subregion the situation survey among irrigation farmers of Groblersdal was completed. Three facets on the promotion of meat production from the veld were registered. Attention will be given to better veld management and the strategic introduction of fodder crops for better feed flow. The situation survey on peach cultivation was also completed and a thorough report was compiled.

In the South-Eastern Transvaal Subregion four demonstration units were developed where the growth increases and/or decreases of each herd of stock on the veld were observed. A total of 22 complete feed flow plannings were completed. Fifteen practice studies were also carried out which were linked to the young ewe flock competition. The findings were arranged and conveyed to the farming community in a programmed manner.

In the Western Transvaal Subregion the farmers are reached by three conservation committees and five study groups. A great deal of attention is given to the reclamation of denuded veld and the land conversion scheme.

In the Lowveld the extension programme was concentrated mainly in the Ohrigstad area. Twelve study groups are involved in persuading farmers to apply optimum management and production practices for subtropical crops.

Free State Region

Natural grazing - During the year under review 31 extension facets directed at improving natural grazing and using it more effectively, continued. A total of 324 group meetings, which were attended by 4 978 farmers, were held in the region. Furthermore, 1 927 farms were visited and 129 newsletters were sent out to 7 080 farmers.

In the Central Free State Subregion in the Brandfort and Theunissen extension wards recognition is given to farmers who have done well, particularly in applying grazing veld management practices. This has a very positive influence on the acceptance of practices. The average grazing period of all participants decreased from 38 days to 25 days. In these wards 48 plannings and replannings of farms in respect of grazing control facilities were done, which is double the figure for the previous year.

In persuading stock farmers in the Central Free State to make and carry out feed flow plannings, the cultivation of perennial pasture on marginal soils plays an important role. Several programmes were undertaken to promote the establishment of perennial grasses on marginal land. A total of 222 farmers applied to establish 23 208 ha of land to perennial pasture during the year.

In the Petrusburg extension ward the objective is to convert 42 900 ha of high-risk land under cash crops to perennial pasture over 4 years. The result of the various programmes in this regard is that applications have been made for the conversion of

25 975 ha, whereas 10 723 ha have already been established successfully.

The combating of invader plants on natural grazing is an important priority in the Vryburg and Postmasburg extension wards. As a result of the programmes 165 farmers applied to participate in the bush control scheme.

In the Vryburg district there is great interest in the land conversion scheme and 330 applications were received to convert 58 021 ha of marginal land to perennial pasture. A total of 18 154 ha were established with pasture during the year. Since the introduction of the scheme applications for the conversion of 87 996 ha have been made, of which 28 322 ha have been established successfully.

In the Gordonia Subregion study groups identified problems, one of which is the keeping of farming records. The study groups are giving attention to factors reducing lamb and reproduction losses. A mutton sheep handbook for the Northern Cape was compiled for use by extension officers and farmers.

Crop farming - Crop production guide-lines were drawn up for all important crops in the Riet River irrigation area and made available to every irrigator. An irrigation scheduling advisory service is rendered to all farmers in the area. The average water consumption for alternative planting dates for wheat, maize, groundnuts and cotton is made available to farmers weekly in order to plan irrigation scheduling.

Winter Rainfall Region

In the Winter Rainfall Region there is a total of 22 registered extension facets to promote farming in this Region.

In the North-Western Subregion approximately 750 000 saltbushes were established successfully and the interest of farmers is still increasing as more production results are made known and establishment techniques improve. Grazing results of collaborators varied from 900 to 2 500 sheep grazing days/ha, depending on the age of the plants. A co-operative trial on the extremely poor soil where the common reed grows indicated that particularly South Coast bietou can be established here very successfully. In the past these lands were regarded as virtually useless from a grazing point of view.

In spite of unfavourable climatic conditions, good progress was made in the Little Karoo with the extension facets directed at drought fodder crops as a supplementary feed source. About 600 ha of saltbush were established during the year and a total of more than 1 400 ha of plantings have already been made by 91 farmers. The use of saltbush camps during the lambing season not only ensures better supervision and care of the animals, but also limits lamb losses as a result of vermin. Collaborators also attest to success with the lamb crop as a result of better feeding conditions during the dry summer.

In a trial with slaughter ostriches on saltbush grazing plus different levels of energy supplementation it was confirmed that a saving of more than 50 % on current feedlot costs is possible.

Persuasion actions to make scheduled irrigation in the Ladismith ward the practice are showing good progress. During the year under review 15 farmers planned their irrigation according to schedules drawn up in advance and also with the aid of tensiometers. A total of 74 tensiometers have been installed on 19 farms.

A facet directed at the promotion of the strategic and practical management skills of grape and fruit farmers in the Wellington extension ward was registered during the past year. A facet to persuade farmers in the Ceres extension ward to apply improved irrigation techniques was also registered during the past year. Farmers were made acutely aware of the usefulness of good irrigation management and in this way a great deal of interest was aroused. Farmers benefit from the better irrigation by better quality and higher production.

In the Worcester extension ward the propagation of improved irrigation management techniques has produced fairly spectacular results. A collaborator who had irrigated freely in the past saved 50 % in electrical power after he began to apply irrigation management. No visible harmful effect on the crop as a result of this saving could be confirmed and, as it happens, the collaborator was the winner of the vineyard block competition of his region.

In the Piketberg extension ward further improvement could be seen in respect of the effort to achieve correct planting density, division of crop soil according to potential classes and fertilisation according to soil analyses and fertilisation guide-lines.

The facet directed at the application of improved techniques of weed control in the Moorreesburg extension ward continued A provisional evaluation shows that aerial spraying decreased from 70 % to 43 %. By contrast, tractor spraying increased from 44 % to 71 %.

In the South Coast Subregion constant attention is given to matters that can stabilise farming and income and increase profitability. Owing to such inputs onion farming has attained its rightful place in the farming pattern of Caledon once more. The industry is profitable and serves as a diversification on irrigation lands, where it makes for a sound rotational crop with grazing crops. Gross margins of R14 000 to R21 000/ha are obtained on the approximately 400 ha of onions cultivated by 56 farmers. Certain operational problems were overcome and the yield increased from an average of 25 to 35 t/ha. Irrigation techniques were improved and less water is used to realise the same and even better yields.

Good results are being obtained in the Bredasdorp ward with the facet of improving production of small stock. It was found that in flocks in which farmers identify their skip ewes and ewes from multiple births and therefore also select them positively for fertility, as well as having rams tested, a weaning percentage of 104 % was achieved as against 87 % in flocks where this practice is not

followed. In addition to the advantage of this increased weaning percentage on the selection differential in the flock, it means a direct increase in the gross margin of at least R6,50/SSU.

Good progress was made in building up the data bank in the extension ward of George and several programmes on aspects such as feed flow, herd management and operational budgets in respect of the most important cash crops, livestock enterprises and grazing crops have been developed.

Advice actions - Technical advice is provided by extension officers on a large scale and during the past year in the Winter Rainfall Region a total of 24 289 persuasion and advice actions by agricultural extension officers took place. In addition, 15 675 farmers were addressed on 865 group occasions.

During the year in the Swartland Subregion the most extensive advice action ever in respect of the pasture establishment scheme was undertaken. 181 applications for the establishment of 24 700 ha of pasture were received.

Extensive advice actions on the land conversion scheme were also undertaken in the South Coast Subregion. During the year 359 applications for the establishment of 25 680 ha of pasture were received.

TRAINING

Training facilities for prospective farmers are available at the five colleges of agriculture of the Department of Agricultural Development, namely Cedara (Natal Region), Elsenburg (Winter Rainfall Region), Glen (Free State Region), Grootfontein (Karoo Region) and Potchefstroom (Highveld Region). Table 1 shows the student numbers at the various colleges.

TABLE 1. Student numbers at colleges of agriculture in 1988/89 and 1989/90

	1988/89	1989/90
Cedara	133	136
Elsenburg	156	195
Glen	146	136
Grootfontein	111	111
Potchefstroom	156	142

Apart from the diploma course the colleges also present a variety of short courses. The Potchefstroom College of Agriculture presented 26 short courses with a total attendance of 796. At Elsenburg 23 short courses were held with an attendance of 733 while the 3 information days were attended by 191 farmers. At the Glen College of Agriculture 9 courses were presented and attended by 136 persons.

AGRICULTURAL INFORMATION SERVICES

Popular publications

During the year under review 124 new and revised leaflets were published in various series. A further 60 information documents on crop production in the summer rainfall area were also published and distributed.

A total of 70 issues of newsletters were edited and prepared for printing. In addition 40 Agricultural Reports of the foreign offices were printed here. A further 130 publications appeared as reports, manuals, lectures and technical and information bulletins. Departmental organisations were also continuously advised on compiling and planning programmes, newsletters, brochures and special publications.

Scientific publications

Articles - During the year under review 75 articles were received - 32 fewer than the previous year. Together with a carry-over of 70, 145 publications were submitted for publication and 114 were approved. Eighty-one of these were published, compared with 73 the previous year.

Apart from these articles, the proceedings of the twenty-eighth congress of the South African Society of Plant pathologists were published in Vol. 22(1), and the proceedings of the ninth symposium of the Nematological Association of South Africa in Vol. 21(2).

Onderstepoort Journal of Veterinary Research - The following issues appeared during the year under review: Volume 56 (2) with 10 articles; Volume 56 (3) with 12 articles; Volume 56 (4) with 13 articles; and Volume 57 (1) with 13 articles.

Forty-eight articles were published, compared with 43 the previous year.

Other scientific publications - During the year under review the Botanical Research Institute was separated from the Department and its publications are no longer handled. The following scientific publications were published: Technical Communications No. 218, 219 and 222; Entomology Memoirs No. 75 and 76; Agricultural Research 1987; Memoirs on the Natural Agricultural Resources of South Africa No. 10.

News service

Agricultural News - During the year under review 50 issues of *Agricultural News* (on average eight pages each) were published. The weekly printing is 6 000 copies.

There was considerable emphasis on the creation of the Agricultural Research Council and financial assistance to farmers and the publication continues to focus on the activities of various regions and institutes.

Most of the reports are used by newspapers, especially in the rural areas. Many reports were followed up for radio talks, television news and articles for journals.

Press statements - About 45 press statements were released and distributed during the year.

Radio bulletin reports - Radio bulletins are

broadcast for 5 minutes in both official languages from Monday to Friday. News bulletins were passed on to Radio Orange and Good Morning South Africa on a daily basis.

Calling All Farmers

The programmes during the year under review clearly reflected the most important events in the agricultural sector. State assistance to farmers and advice concerning financing enjoyed extensive coverage throughout the year. Broadcasts on the international symposium on the cultivation of subtropical and tropical fruit and the count-down to the International Merino Conference during Wool Expo '90 elicited much interest. The campaign to encourage land conversion and proposals for the cultivation of alternative crops, continued. Projects concerning the upliftment of communities and the activities of the Rural Foundation received attention, as did the extension of electricity supply on farms and mechanisation planning.

The activities of the different research institutes of the Department and the activities of the Marketing Boards were elucidated, especially in respect of market-orientated production. Prominence was also given to agricultural training, especially the foundation of the new Lowveld College of Agriculture at Nelspruit.

The agricultural programme on Saturday mornings continues to enjoy wide interest from listeners. Topics of a varied nature are discussed and programmes of special interest to the farmer's wife, such as home industries, gardening and hobbies, were presented.

Audio-visual Services

The Division of Audio-visual Services produces a weekly programme insert for broadcasting by the SABC on the agricultural programme *Agriforum*. These inserts are aimed at representing the entire spectrum of activities of the Department in the interest of the farmer.

Themes varied from the utilisation of solar energy, the control of erosion in pineapple lands, the control of prosopis to programmes on the success of the fine-wool project, research on proteas and veld burning.

Training-orientated programmes are made for broadcasting, but also for use in colleges of agriculture and by extension officers. A series of programmes on vineyard tillage and a programme on the setting of a planter were completed during the year under review.

The number of *Agriforum* viewers doubled since last year to 1,5 million.

An agreement was reached with the National Film Library and the videotheque of the South African Agricultural Union for further distribution of programmes to schools and farmers.

Documentation Centre

The Documentation Centre continued to operate as a complete and established service centre, rendering services to both Departmental and private users. Since the personnel were at full strength, an attempt was made to improve both the quality of retrieval and speed of delivery. The Centre succeeded in providing the SDI service virtually on a monthly basis.

The average number of users that availed themselves of the three databases CAB (Commonwealth Agricultural Bureaux Abstracts), FSTA (Food Science and Technology Abstracts) and VITIS/VEA (Viticulture and Enology Abstracts) for the SDI service every month, were 957, 37 and 4 respectively, while 381, 42 and 5 retrospective users' profiles for the three databases were completed.

Because of the high cost of data storage, duplicate references that occurred in the CAB databasis were removed. This measure is estimated to result in a monthly saving of at least R5 000 in storage space costs. Important adjustments made to the CAB database considerably improved the retrieval strategy.

As a further cost-saving measure, information was printed on both sides of the paper and only the seven most important paragraphs of documents were supplied, instead of the whole document as was the case in the past. This measure was generally approved by users and reduced paper consumption by about 50 %.

The following databases were expanded:

Agricultural News - All news items in every issue have been summarised in this database since 1988, and 3 773 items have been recorded.

Speeches - Speeches have been computerised since 1986 and 772 items have already been recorded.

Travel reports - All travel reports of Departmental officers who pay official visits abroad, are stored in the travel database so that essential particulars of every foreign trip will be available. More than 1 400 have been recorded.

Investigations are being made into the possibility of making information available to users on floppy disks. The additional cost must be established.

Agricultural libraries

The Mary Gunn library of the Botanical Research Institute was taken over by the National Botanical Institute. A library was established at the new Lowveld College of Agriculture and the librarian post at the Tobacco and Cotton Research Institute was filled.

The high prices of, especially, foreign publications and the scaling-down of research projects caused a drop in acquisitions from 2 057 in the previous year to 1 689 in 1989/90 - a decrease of 17,9 %. Despite this, issues increased by 5,6 % to 30 198.

Other users' services that were in great demand were the compilation of bibliographies, the circulation of journals and the answering of queries. Library personnel also acted as liaison officers between agricultural researchers and the Documentation Centre (SADAL).

Most libraries own microcomputerised or computer terminals. A variety of library tasks were computerised. Ten libraries are linked up with SABINET, the bibliographic information network for South Africa. Personnel are already competent in handling retrievals from SABINET and also feed in bibliographic information on this database.

AGRICULTURAL ENGINEERING SERVICES

Agricultural implements

Applied research and development - The concept of conservation tillage in wheat appears to be so successful that it is slowly but surely beginning to take root among producers. It includes the planting of wheat under mulching conditions and the use of herbicide sprayings.

Field and laboratory trials were done to evaluate the application of herbicides with boom sprays in respect of effective control and minimum input costs. The results are already being applied successfully.

An experimental rooibos tea fermenter was developed for the Fruit and Fruit Technology Research Institute. It is used to control relative humidity, temperature, air speed and percentage of fresh air during fermentation and drying of the tea.

A series of computer programmes was developed to process solar data, psychrometric data, material and other features to make quick and accurate calculations of heat stress and cooling capacity.

An investigation was launched on behalf of the Land Bank into the necessity and technical correctness of expansions at co-operative wine cellars. Projects to the value of R27 million were handled.

Overall requirement determinations of wine cellar equipment were done for 12 cellars on the basis of production analyses and forecasts.

Application problems experienced with a locust-control machine were identified and adjustments were recommended in order to prevent them. These adjustments can be made easily by the supplier of the equipment.

A private firm was supported by means of advice and guidance in the development of a successful high density press baler.

After extensive investigations a disturbing tendency to break of a series of locally manufactured soil tillage spring tines was identified as being the result mainly of insufficient heat treatment practices during manufacture.

The annual retail sales figures for agricultural engineering equipment and implements for 1989 were compiled. They reflect mechanisation trends.

Research on agricultural energy

Sunflower oil as fuel - The use of sunflower oil as fuel for tractors proved technically successful. However, altered strategies and cost factors did not justify further development and the project was abandoned. The lower oil price, expansions of SASOL, developments in Mossel Bay and the high production costs of sunflower oil are some of the most important reasons. If there was another oil crisis, a sufficient technological basis has been established for further development.

Solar energy - A new solar-driven water pump is being developed and will be an improvement on the previous design. The new design no longer use freon gas, but water, and is therefore ozone-friendly. The heat source is the sun's rays, which will be concentrated with parabolic mirrors. The hotter it is, the more water can be pumped.

Wind energy - Experiments are being done to concentrate wind power on a wind turbine by means of a cone. The higher wind velocity obtained in this way will make more places in the country suitable for wind power generation and also result in a smaller and cheaper wind turbine.

Hydro-energy - The working performance of a prototype water-wheel in pumping water from a river is monitored regularly.

Biogas - An information document dealing with the generation of biogas from animal waste and plant material is being compiled. This source of energy is virtually untapped in South Africa.

General - A lead battery maintenance manual is being compiled.

The comparative heat values of maize stalks as against coal were determined so that this source of heat energy can be used more.

Agricultural structures and facilities

Manure handling - Problems that occurred in the drum-type manure separators were solved and several of these separators are now used throughout the country. Research into the composting of cattle manure with the aid of aeration is continuing and attention will also be given to the composting of animal waste with the use of earthworms.

Manuals - Manuals on milking machines, dealing with beef cattle and poultry housing have been compiled and made available. Several other manuals on agricultural structures and facilities are being compiled or revised.

Game farming - The improvement of catching, handling and holding facilities for game is being investigated. The objective is to create a manual which will contain the necessary guide-lines and plans so that game losses are kept to the minimum.

Aquaculture - This year a start was made on giving intensive attention to the aquaculture industry

in South Africa. Advice has already been given concerning feed processing facilities for the small farmer, the design of a feed trial unit for the University of Pretoria, the biological filtration of breeding house water and the construction of earth dams.

Climate control - Three polycarbonate hot-houses were erected for Departmental research during the year under review. Polycarbonate cladding still produces the best results.

Three complete glasshouses with air conditioning and temperature control and a cooling room for use as a laboratory for biotechnological research were also erected at research bodies of the Department.

Wire fences - An investigation into the corrosion of wire fences on farms is being launched. Organisations such as the SABS, the CSIR and fencing manufacturers are involved. The effect of veld fires on galvanised wire fences is also being investigated.

General - Guidance on agricultural structures and facilities is given to farmers, study groups, students and others in the private sector on an ongoing basis.

Grain silos

Technical advice - With the abolition of the Grain Silo Committee, the official function of technical advisor for this body has fallen away. However, because of a great need for expert advice, services are still provided for the control boards and the grain industry. The upgrading of old grain silos is still done regularly. The greatest problems are slow intake rates and obsolete equipment.

Investigations - An investigation was carried out in the Rûens area to determine the long-term capacity requirements for grain (particularly barley). All relevant bodies are involved.

Research on the use of mineral or vegetable oils to limit dust on grain was done. Furthermore, the determination of norms for grain silos and the rewriting of procedures that must be followed on an application for upgrading or expansion continued.

Electronics and electrical engineering

Electronics and instrumentation - Two instrument units for research into water drainage were developed from the combination of various commercially available instruments.

An electronic circuit prototype was developed to control the movement of solar panels in order to gather the maximum solar energy for charging batteries. The solar panels follow the sun during the day.

An electronic locust sprayer speedometer was developed which indicates by means of three light emission diodes whether the speed of the fan is too low, correct or too high.

A start was made on the planning and development of computer-controlled systems for growth chambers. Programmes are also being developed to excercise climate simulation control.

A fruit size meter was developed which monitors the growing process of fruit on trees and which registers up to the nearest 0,001 mm.

A pilot investigation was carried out on a mechanical-electronic measuring instrument which will be able to determine when pecan nuts are going to burst as a result of internal pressure that is too high.

Irrigation boards

Successful negotiations with the Land and Agricultural Bank of South Africa resulted in loans in respect of approved irrigation board schemes being financed by the Land Bank from 1 March 1989. This arrangement saves considerably on State expenditure since the State is required to provide only the one third subsidy on approved irrigation board schemes.

During the course of the 1989/90 financial year almost R18 million was spent on irrigation board schemes, of which the State paid out about R6 million in subsidies. State expenditure was therefore less by almost half than in the previous financial year, whereas private investment in irrigation board schemes increased by more than 50 %.

During the year about 400 subsidies with a total value of almost R3 million were paid out to private farmers who completed approved irrigation works.

Drilling Services

During the year under review the total expenditure for the operation of the Government Drilling Services was almost R10,4 million, excluding subsidy payments of R939 360 to private drilling contractors, R110 540 for additional works and R300 839 for private drilling contract work still continuing in the Designated Area.

The Drilling Services sank 1 362 boreholes with a yield of almost 5,6 million ℓ/hour. In terms of the subsidy scheme a further 663 boreholes with a yield of 1,1 million ℓ/hour were sunk by private contractors.

Soil conservation engineering

During the year under review 9 208 works were completed and subsidies of R8,79 million were paid out in respect of these works. The table shows the progress as against the previous year.

The disaster drought works made up a large part of the work and consequently hindered the activities under the soil conservation scheme.

	1988/89		1989/90	
	Number of works	Subsidy paid out R	Number of works	Subsidy paid out R
Contour banks	1 753	1 880 253	1 701	1 703 432
Soil conservation structures	490	490 460	82	500 199
Erosion fences	81	30 722	64	32 098
Subterranean drainage works	349	1 106 812	329	1 164 377
Camp fences	1 645	304 983	2 012	418 047
Stock-watering systems	496	441 459	504	488 933
Flood relief schemes:				
Ordinary . . .	90	467 088	26	28 164
Disaster . . .	2 106	1 400 146	3 902	3 589 304
Drought relief	1	96	–	–
Bush control	474	649 870	588	866 471
Total	**7 485**	**6 771 889**	**9 208**	**8 791 025**

Nevertheless progress was made with the erection of grazing utilisation works and bush control. However, there was a decrease in the erection of soil conservation structures. Apart from the fact that a great deal of time was spent on the flood disaster scheme, the decrease may be attributed to the fact that farmers found it financially difficult to erect such works with the low subsidy tariffs.

Technical support was offered in respect of rainfall simulator projects in the Free State and Eastern Cape Regions.

Advice was given in respect of the safeguarding of worked out asbestos mine dumps so that the asbestos fibre does not spread any further.

During the year under review another three national soil conservation handbooks for technicians were printed and distributed. Work is being done on three revisions and three new handbooks.

PASTURE RESEARCH

VELD RESEARCH

Ecology

Good progress has been made at the Grassland Research Centre with the development of new phytosociological classification methods. It is now possible to classify vegetation objectively, with repeatable results. Classification can now be done in days, instead of months as in the past. In the Upper Limpopo Valley enough data have been collected to monitor veld conditions, particularly in respect of bush encroachment.

The effect of the annual application of nitrogen and phosphorus on veld at Potchefstroom was investigated. The fertilised and unfertilised camps (which served as controls) were grazed by young oxen.

The results have shown that the typical climax species in the fertilised camps have completely disappeared with time. These are grasses such as *Themeda triandra, Elionurus muticus, Heteropogon contortus, Cymbopogon plurinodis, C. excavatus* and *Hyparrhenia hirta.*

On the other hand, grasses such as *Digitaria eriantha, Eustachys paspaloides, Cynodon dactylon, Setaria sphacelata* and *Aristida congesta* have increased.

In comparison with the unfertilised veld, there was a decrease in the basal cover on the fertilised veld. A large increase in herbs was also observed on this veld.

Ecologically, fertilisation therefore started a retrogressive succession process. However, the grasses that took over were almost all very palatable. Owing to the fertilisation, they yielded a higher production per animal and per hectare than the veld without fertilisation.

Research has shown that *Acacia* species initiate the problem of bush encroachment in the bushveld of Natal. To obtain a thorough knowledge of the growth of this species, an autecological study was launched in the lowveld of Natal to investigate the life cycle of *Acacia* species.

Key plants were identified in the sweet and mixed grassland, the thorn scrub and the succulent bushveld of the Eastern Cape Region. Research focused mainly on the interaction between *Acacia karroo* and the grass component in the semi-arid thornveld.

This work is done in both good and poor veld and stretches from low rainfall to high rainfall areas. Good norms are obtained in respect of the effect of bush density on grass production in the different rainfall zones in various veld conditions.

Veld conditions and monitoring

The Grassland Research Centre is undertaking a national project to determine the current veld condition of the vegetation of the RSA on a national basis and then to monitor it regularly. A technique has been developed whereby veld condition can be determined with the aid of the Landsat TM satellite. This work is undertaken by the Soil and Irrigation Research Institute.

The veld condition has been monitored over the past 15 to 18 seasons at 52 places in the extensive grazing areas of the Winter Rainfall Region. Data from 26 of the most important areas have been analysed. From this it is evident that the veld condition has changed very little over this period, and no long-term trends could be observed.

The composition and cover of the veld was very poor throughout, with the total cover average as low as 44 %, 39 % of which was edible plants.

In order to establish norms for veld condition description in the Highveld Region, a start was made on botanical surveys on pasturing gradients in six land types. With the aid of computer ordering techniques, grass communities and the most important habitat factors have been identified.

The determination of the grass communities in the first land type (DC 10) between Lindley and Kroonstad has been completed. The most important habitat factor influencing the grass communities in each veld condition class was soil texture. Here, a distinction could be made between sandy loam and clay loam soils.

At 70 different places in the Free State Region exclusion stands have been established at which veld production and veld condition are measured. Four years of production data have been collected on a species basis. This information will be used for quantifying the grazing capacity of the various areas.

Grazing capacity, management and utilisation

Two matters are studied, particularly in the *Karoo*, *viz.* the estimation of grazing capacities by means of long-term carrying capacity trials and the estimation of grazing values of different types of Karoo bush and grass. The purpose is to establish the short and long-term grazing capacities of the various veld types by means of veld surveys, production and climatic information.

The long-term grazing capacity trials produced the following animal production results:

Carnarvon: The best average daily increase (ADI) of Afrino sheep at grazing capacities (GC) of 4, 5,5, 7 and 8 ha/SSU, over a period of 163 days, from April to October was 82 g/day at the GC of 8 ha/SSU. The average of all treatments was 72 g/day.

Grootfontein: With Angora goats, at GC 0,7, 1,4 and 2,9 ha/SSU, over 365 days from March to March, the best ADI was 11 g/day at GC 2,9 ha/SSU, while the average of all treatments was 3 g/day.

With Dorper sheep, at GC 1, 2 and 3 ha/SSU, over 365 days from March to March, the best ADI was 55 g/day at GC 3 ha/SSU, while the average of all treatments was 43 g/day.

With Merino sheep, at GC 1, 2 and 3 ha/SSU, over 365 days from March to March, the best ADI was 33 g/day at GC 3 ha/SSU, while the average of all treatments was 30 g/day.

Three comprehensive grazing capacity studies are being carried out in the Free State Region, *viz.* at Armoedsvlakte with cattle, at Koopmansfontein with Dorper sheep and at Glen with Merino sheep and cattle. The negative effect of overgrazing on veld condition, food supply and animal production has been demonstrated at all of these places.

The data from 26 places in the extensive grazing areas of the Winter Rainfall Region where the veld conditions are monitored every year were used to estimate the grazing capacity of these places. It was calculated that the grazing capacity is an average of 5,4 ha/SSU over all the areas. This is only about 13,5 % of the potential grazing capacity.

Results of a sheep:cattle ratio trial in the sourveld at Kokstad indicate an increase in animal performances when sheep graze with cattle. Increased animal performances can be expected when the ratio is 1:1 (on a stock unit basis), or at a ratio that favours cattle.

Problem plants

The research programme on the control of problem plants in the Free State Region continued. The most important species given attention were: *Acacia* types, *Terminalia sericea, Stoebe vulgaris* and *Tarchonanthus camphoratus.*

The control includes the integrated use of chemical agents, fire and veld management. During the past season, there was an increase of up to 700 % in grass production on the treated stands.

The application of sound veld management principles, which include a follow-up programme, largely determines the success of such control.

Drought characterisation

In the central grassveld areas of the Free State Region droughts have been quantified in terms of veld production. The simulation model to determine the growth and production of grassveld has been adapted so that veld condition can also be taken into account.

Other models are being developed to quantify droughts in terms of animal production.

Veld reclamation

From the monitoring programme in the Winter Rainfall Region it is clear that natural veld in the Ceres Karoo and Little Karoo is maintained in a very stable and unproductive condition by ecologically well-adapted, but inedible plants such as *Pteronia pallens.* These plants occur in dense stands of up to 7 500 plants/ha.

Any form of removal of these plants, particularly if combined with cultivation, usually leads to the re-establishment of other plants. The sowing of plants on uncultivated areas and where there has been only light tilling with a tined implement has produced little success.

More success is achieved by preparing a better seed bed and at the same time removing the *Pteronia pallens.* Four species (*Atriplex nummularia, A. cana, A. canescens* and *A. semibaccata*) were sown in this way in a trial and stands of 7 850 to 12 875 plants/ha were obtained. These stands have a grazing capacity of 1 to 2 SSU/ha as against 20 ha/SSU on natural veld.

The Strandveld of the West Coast is an open, semi-succulent shrubveld of which most of the shrubs are relatively unpalatable and compete with low-growing, more palatable shrubs and grasses. In an attempt to remove the unpalatable shrubs, a roller treatment was applied.

The roller treatment drastically reduced the unpalatable shrubs such as *Zygophyllum morgsana* (skilpadbos) and *Ruschia cymosa* (rooivyehout), while it increased the more palatable shrubs such as *Hermannia scordifolia* (geelkruipbroodbos) and also grasses such as perennial veld grass (*Ehrharta calycina*).

CULTIVATED PASTURE

Introduction and collection of new lines and cultivars

At the end of the period under review, the gene bank at the Grassland Research Centre contained about 3 000 acquisitions, 2 000 of which are legume plants and 1 000 grasses.

A total of 40 new legume acquisitions were obtained by means of introduction, whereas 700 grasses were obtained by means of collection.

For the evaluation of promising acquisitions in respect of climate adaptation, production and possible application, nine trials were transferred to five research stations, while 12 new trials were planted. Various ecotypes and/or cultivars of the genera *Aeschynomene, Arachis, Centrosema, Desmanthus, Glycine, Leucaena, Lotononis, Macroptilium, Ornithopus, Stylosanthes* and *Vigna* were such a success that livestock evaluation should now be done.

Promising lines in various climatic regions

The hay and simulated grazing production of six oat, three triticale and one rye cultivar was evaluated over 4 seasons at five places in the Swartland. The places differed in respect of the amount of rainfall,

soil type and duration of the growing season.

The highest yield of hay was observed in an area with a high rainfall and sandy soil, whereas the highest grazing production was achieved on heavy soil and with a high rainfall.

The rye cultivar Henoch produced the highest grazing and hay yield. The triticale cultivars had a higher yield of hay than the oat cultivars, but only one cultivar, USGEN 7, could equal the grazing production of the Swartberg, Overberg, Perdeberg and Heros oat cultivars.

A total of 18 medic cultivars and lines were evaluated co-operatively in the Nuwerus area in the Winter Rainfall Region. Although the commercial cultivars produced amazingly high yields at a rainfall of 150 mm, certain early lines of *M. truncatula* produced yields of up to 1,9 t dry material/ha.

The commercial cultivar which produced the highest seed yield, *viz.* 135 kg/ha, was Cyprus (*M. truncatula*). Three of the early lines of the same species, *viz.* SA 11979, SA 17214 and SA 17215 produced a seed production higher than 260 kg/ha. The lines therefore have great possibilities for this dry area.

Five lucerne cultivars, SA Standard, CUF 101, Granada, Baronet and Siriver are being evaluated for grazing resistance by two grazing methods (continuous and rotational) and three stocking rates (6, 8 and 10 sheep/ha).

SA Standard performed very well and even at the highest stocking rate 80 % of the plants survived.

With rotational grazing, all the cultivars except Granada performed relatively well. This shows that rotational grazing is necessary where the newer, aphid-resistant cultivars are used for grazing.

Known and new grazing crops are continually evaluated in the Free State Region. The grasses *Anthephora pubescens, Chloris gayana, Digitaria eriantha* and *Eragrostis curvula* are still receiving attention. Promising results are being achieved, with productions varying from 3 to 6 t/ha.

The resistance of 25 lucerne cultivars to grazing is being investigated. The cultivar Granada is apparently not adapted to grazing and cultivars that are not dormant in the winter are less resistant to grazing than cultivars that are dormant in the winter.

The climatological adaptability of a wide range of lucerne cultivars is being investigated at three places in the Free State Region under cutting conditions. Promising cultivars are CUF 101, Moapa 69, Pioneer 4860, Pioneer 4863, Diamond, Baronet and Pierce.

Production and growth of forage crops

Aphids, particularly the pea aphid (*Acyrthosiphon pisum*), the blue-green lucerne aphid (*A. kondoi*) and the spotted alfalfa aphid (*Therioaphis trifolii*), are among the most important insect pests of lucerne in the Winter Rainfall Region. The numbers of the three aphids are monitored regularly on six lucerne cultivars cultivated at three stocking rates.

It has been found that aphids occur in definite seasonal patterns. The different lucerne cultivars are infested to varying degrees, and the highest stocking rate has a suppressive influence on the number of aphids.

The influence of sowing density and row width on the production of lucerne has been evaluated since 1984 in the Free State Region. During seasons with low rainfall, the best production was obtained at the lowest sowing density. The opposite is experienced in seasons with high rainfall.

One of the causes of a failed planting on lands withdrawn from cash crops, is the influence of long-lasting herbicides on young grass seedlings. Atrazine is one of the herbicides with which problems are experienced in practice.

In trials it has been shown that there are great differences in sensitivity to atrazine between the different forage crops. *Medicago sativa* seems to be the most intolerant, followed by *Panicum maximum* and *Digitaria eriantha,* whereas *Anthephora pubescens* was the most resistant crop.

In the Natal Region attention is given particularly to nitrogen as a limiting factor in production and factors which limit production of promising lines on acid soils. Kikuyu, an important grazing grass, is being studied intensively. Attention is focused primarily on factors responsible for the poor quality of kikuyu. It appears that the low calcium content of kikuyu has a negative effect on the digestibility of the grass.

Characterisation of preferential lines for animal production

The potential of *Anthephora pubescens* and *Cenchrus ciliaris* for finishing young growing animals in the summer is being investigated in the Free State Region. Promising biological and economic results are being obtained.

During the past 3 years the role and value of dryland lucerne as summer grazing for a ewe with her lamb has been evaluated in the Highveld Region. The ewe with her lamb until it was weaned and the lambs for finishing after weaning could not be kept successfully on the same area, because lucerne is very sensitive to the mid-summer droughts.

The use of lucerne in autumn also seriously hampered the next spring growth. Lucerne therefore cannot be used as the only grazing during the summer.

The value of Smuts finger grass as standing hay, with and without supplementation, for Afrikaner tollies was investigated at Potchefstroom. The utilisation period of the standing hay, which was divided into two phases, extended from the middle of August to the middle of November. A winter lick was available *ad lib.*

With the supplementation of hay for the full trial period at 2,5 kg of hay/tollie/day an average daily mass increase of 0,56 kg/tollie was achieved. Where 5 kg of ha/day was provided only for the second half of the trial period, the increase was 0,49 kg/tollie.

The animals that depended on standing hay alone for the full period could only maintain their starting mass.

The potential of cultivated pastures in terms of animal production is being investigated in the coastal area of the Eastern Cape and in the Dohne Sourveld. The primary purpose is to find a low-cost pasture. Coast Cross II appears to be a very promising species, but the economy of beef production on grass pastures is doubtful. In the Dohne Sourveld, the problem is to find a suitable pasture for overwintering. Vetch is possibly an alternative to oats.

Research at Kokstad shows that *Festuca arundinacea* is suitable for sheep production systems. Good meat and wool production are obtained on these pastures. Good sheep production is obtained on lucerne, but the results are dependent on stocking rates and the distribution of rain.

Plant upgrading

The Grassland Research Centre is undertaking the following:

Digitaria eriantha - This programme was planned first to make selections of plants suitable for different farming practices. Of these, progenies are being evaluated for heritability of certain features. Secondly, the cultivar Irene is being described so that there is a standard for the description of new cultivars.

Cowpeas - Preliminary examinations are being done in respect of features such as dehiscence of seeds, petal fall and disease resistance with a view to the development of a cultivation programme.

Rye grass - Several rye grass precultivars are being described and investigated with a view to release. These include Italian, Westerwold and perennial rye grass cultivars.

Festuca arundinacea - New inputs have been made in respect of the development of the *Festuca* cultivation programme and active introduction and selection of parents and cultivation work is being done.

Dusi white clover - Seed production of Dusi is a problem being investigated at Cedara and Roodeplaat. Several seed companies have contracts for the overseas production of seed. It is essential that seed from this very promising acid-resistant white clover is made commercially available within the near future.

The National Lucerne Evaluation Programme - There are more than 80 lucerne evaluation trials taking place. The trials at Roodeplaat show great differences in respect of stability and production potential in the fourth year. It has been recommended that ten additional cultivars be registered on the SA variety list. This has brought the total to 25.

Fodder conservation and utilisation

Foggage - The use of Smuts finger grass (*Digitaria eriantha*) for foggage for beef animals is being evaluated at Kokstad. Indications are that if closed down too early in summer (December) there is an excess of low quality material, associated with excessive trampling when utilised.

If closed down too late (after 15 February) there is too little material and the pasture is susceptible to invasion by winter weeds.

Preliminary indications are that closing down at the end of January provides foggage suitable for maintenance of dry beef cows and weaners.

Grass silage - *Digitaria eriantha* silage, made without additives when the plants were in the late flowering stage (February/March), was found to be acceptable to mature pregnant dry cows and weaners. When it was fed *ad lib* to these classes of animals live mass gains of 0,35 and 0,42 kg/head/day were recorded.

A study on the effect of using different additives when making kikuyu silage yielded interesting results. The use of Ecosyl, Agril-Silage and Nystatin did not improve the quality of kikuyu silage prepared in laboratory silos.

Molasses was applied at different levels to unwilted kikuyu silage made in small tower silos. The results showed significant differences between the chemical composition of the different silages. However, the intake by sheep and the digestibility of dry matter of these silages did not differ significantly.

AGRICULTURAL FINANCE

Agricultural Credit Board

During the past year the Agricultural Credit Board dealt with 6 289 cases, as against 6 623 the previous year.

Granting of assistance

Schemes for purchasing implements and those for waterworks, sinking boreholes, eradicating invader bush, afforestation, effecting improvements and purchasing land outside the Designated Areas could still not be continued.

A total of 154 applications for settlement proposals were considered and assistance to the amount of R12 601 910 was granted to 71 applicants.

The amounts granted by the Agricultural Credit Board during the year, the number of loans and the number of cases rejected are shown in Table 1.

TABLE 1. Particulars of assistance given

Scheme	1989/90 Number of loans granted	1989/90 Amount granted R	Number of applications rejected
Purchase of means of crop production (seed, fertiliser, fuel, etc.)	2 248	113 418 700	433
Purchase of livestock	37	1 658 700	76
Soil conservation works	85	5 361 500	2
Waterworks	4	845 000	
Drilling	4	24 213	1
Purchase of agricultural land and grants of land	65	13 625 900	179
Improvements or repairs	2	123 600	2
Payment of farming debts, including mortgage debts	534	52 174 705	676
Housing for farm labourers	6	175 000	1
Disaster aid: Stock feed scheme in scheduled grazing distress areas, including the transportation of drinking water for livestock	1	20 700*	–
Flood relief scheme: Natal flood, September 1987 and Orange Free State flood, March 1988	65	1 928 200	3
Total	**3 051**	**189 356 218****	**1 373**

* Only subsidies

**Amount actually spent on loans, about R198 million

Assistance in the Designated Areas

North and North-Western Transvaal and Northern and North-Western Cape border areas - The usual assistance schemes such as those for the purchase of land, debt consolidation, settlement proposals, the purchase of livestock, etc., still apply in the Designated Areas. An amount of R38 828 700 was paid out in terms of the various assistance schemes.

State land

Table 2 shows the State land allocated or sold as agricultural land to successful applicants during the year under review.

Short-term assistance

Crop production loans of up to a maximum amount of R75 000 were granted in the recognised cropping areas of the country.

Particulars in this connection for the past 4 financial years are given in Table 3.

Long-term assistance

Table 4 gives details of applications considered and granted by the Board during the past 4 years.

TABLE 2. Particulars of State land sold

	Area ha	Value R	Number of applications	Number of tenders	Number of units
Economic units	13 548	3 601 140	471	–	14
Uneconomic units	18 934	4 007 538	85	69	66
Total	**32 482**	**7 608 678**	**556**	**69**	**80**

TABLE 3. Loans and amounts granted for purchase of means of crop production

Financial year	Applications considered			Loans granted		
	Number	Amount R	Average R	Number	Amount R	Average R
1986/87	3 127	141 169 408	45 145	2 741	111 778 793	40 780
1987/88	2 302	169 649 000	73 675	1 166	129 934 000	111 436
1988/89	2 976	160 743 394	54 013	2 613	124 483 823	47 640
1989/90	2 681	210 664 200	78 372	2 248	113 418 300	50 453

TABLE 4. Summary of aid granted during the past 4 years

Scheme and financial year	Applications considered			Loans granted		
	Number	Amount R	Average R	Number	Amount R	Average R
Land purchases						
1986/87	156	51 176 757	328 056	58	10 409 087	179 467
1987/88	326	100 816 576	309 252	137	29 497 443	215 310
1988/89	266	73 197 442	275 178	96	20 482 670	213 361
1989/90	244	82 396 700	337 691	65	13 625 900	209 629
Improvements						
1986/87	6	2 318 432	386 432	2	100 000	50 000
1987/88	1	27 000	27 000	–	–	–
1988/89	1	88 000	88 000	1	75 000	75 000
1989/90	4	123 600	30 900	2	123 600	61 800
Discharge of debts						
1986/87	2 298	523 702 119	227 895	827	60 561 377	73 230
1987/88	2 407	578 214 302	240 221	1 158	114 080 720	98 514
1988/89	1 094	251 567 387	229 952	556	55 603 363	100 006
1989/90	1 210	367 191 700	303 464	534	52 174 705	97 705
Soil conservation works						
1986/87	69	1 616 339	23 425	67	1 593 552	23 784
1987/88	55	1 893 549	34 428	53	1 745 202	32 928
1988/89	56	2 120 558	37 867	55	2 351 759	42 759
1989/90	87	5 496 400	63 177	85	5 361 500	63 076
Waterworks						
1986/87	10	434 425	43 442	2	53 383	36 692
1987/88	7	641 293	91 613	4	347 333	86 833
1988/89	7	503 006	71 858	3	226 130	75 377
1989/90	4	845 000	211 250	4	845 000	211 250
Housing for farm labourers						
1986/87	516	11 749 060	22 769	488	10 955 660	22 450
1987/88	720	19 669 762	27 319	694	19 198 526	27 663
1988/89	496	15 701 710	31 657	473	14 520 198	30 698
1989/90	7	318 800	45 543	6	175 000	29 167
Livestock						
1986/87	87	4 213 060	48 426	19	526 700	27 721
1987/88	86	4 526 450	52 633	13	717 000	55 154
1988/89	86	6 472 400	75 260	22	1 080 800	49 127
1989/90	113	7 798 000	69 008	37	1 657 700	44 802
Implements						
1986/87	5	153 705	30 741	2	62 700	31 350
1987/88	3	201 700	67 233	3	201 700	67 233
1988/89	5	166 032	33 206	–	–	–
1989/90	3	95 000	31 667	3	97 400	32 466

TABLE 5. Number of districts where disaster drought assistance were given

Province	Date	Stock grazing scheme	Field husbandry scheme
Cape Province	1989-03-31	27	3
Orange Free State		6	1
Transvaal		7	3
		40	**7**
Cape Province	1990-03-31	8	2
Orange Free State		–	–
Transvaal		4	–
		12	**2**

Drought assistance schemes

During the year under review agricultural conditions improved to such an extent that the disaster drought assistance for several districts or sections of districts could be discontinued. Table 5 contains particulars on the course of the schemes and Table 6 shows the expenditure.

TABLE 6. Disaster drought assistance granted to stock farmers in terms of the various schemes in comparison with that of the previous year

Year	Rebates	Loans	Subsidies and incentive
1988/89	R2 943 975	R945 438	R73 207 597
1989/90	R5 564 000	R694 000	R10 503 200

Scheme for farmers in the summer rainfall cropping areas

This is a special drought assistance scheme for the summer rainfall cropping areas in terms of which State-guaranteed Land Bank loans are made available to co-operatives, so that members who have suffered crop damage can have extensions for the repayment of production debts and so that new production credit can be given to them for the following season. This is a Land Bank scheme administered locally by the co-operative concerned.

Carry-over debts with co-operatives that cannot be covered by crop yields are divided into two categories, namely the 5-year and 10-year schemes.

The local co-operative identifies the farmer who qualifies for assistance and includes him in a scheme.

The State has given the Land Bank a guarantee of R800 million in terms of which payment is undertaken if drought assistance debt of members of co-operatives who have followed the provisions of the scheme cannot be recovered.

Carry-over debts of deciduous fruit producers in the Langkloof were also included in the 5-year scheme of the drought assistance scheme for farmers in the summer rainfall area.

1987 carry-over debt scheme for stock farmers

This scheme is applicable in the extensive stock grazing areas were the drought assistance scheme was applied or is still being applied. The maximum amount involved is R100 000 per applicant. In terms of this scheme the interest rates on such debts with co-operatives are subsidised. During the year under review R293 101 was paid out in subsidies.

1989 drought assistance scheme for winter grain producers in the Southern Cape

As a result of the crop damage experienced by winter grain producers in the Southern Cape since the introduction of the 1987 drought assistance scheme, a new carry-over debt scheme was introduced for the area. In terms of this scheme interest subsidies are paid on carry-over debts and in respect of new production credit with the Land Bank and the Agricultural Credit Board.

Expenditure on interest subsidies

During the year under review the total interest subsidies amounted to R185,4 million.

Water quota subsidies

Subsidies were paid in terms of the Koster River, the Olifantsnek and the Buffelspoort/Middelkraal Government water schemes in the Rustenburg district (the scheme ended on 31 July 1989). These allowed farmers to remain on their farms until sufficient irrigation water (50 % of the water quota) becomes available and production can continue.

During the year under review R366 000 was paid out in subsidies.

Conversion of cultivated marginal land to land under perennial pasture crops

Scheme 1 - This scheme came into operation on 1 October 1987 and was adapted on 1 August 1988 and 1 November 1989 for the recognised dryland summer rainfall cropping areas. Depending on the availability of funds, the scheme has been extended country-wide on a limited scale. Establishment can take place up to 1992/93.

Scheme 2 - This scheme came into operation on 1 April 1989 in certain parts of the Western and Southern Cape. Farmers had the opportunity of joining the scheme up to 31 March 1990. The purpose of the scheme is to reduce the excessive dependence on wheat cultivation in the Winter Rainfall Region.

Various approved perennial and/or self-establishing legume crop pastures and old-man saltbush can be established. During the year under review R30 331 100 was paid out in subsidies in terms of this assistance scheme.

Interest subsidy on the production credit of farmers with commercial banks in the drought-stricken summer rainfall cropping areas

The existing scheme was extended for the 1988/89 production season. The scheme applied from 1 May 1988 to 30 April 1989 in respect of winter crops and from 1 September 1988 to 31 August 1989 in respect of summer crops in the summer rainfall cropping areas.

During the year under review R72 150 was paid out in interest subsidies.

Financial assistance scheme in identified drought disaster areas of the summer rainfall cropping regions (1988 input subsidy)

Although this scheme was closed on 31 August 1988, an amount of R545 500 was paid out during the year under review in respect of applications that could not be dealt with during the previous year.

Special financial assistance scheme for ostrich farmers in the Little Karoo

Owing to the unique situation of the ostrich industry and also the drought, a special assistance scheme was introduced on 1 October 1989 in certain sections of the districts of Oudtshoorn, Calitzdorp, George and Uniondale.

The assistance measures include a lump-sum subsidy of R15 per month per ostrich up to a maximum of 125 ostriches. The amount of R15 represents R7 for the rebate on the transport costs of approved stock feed by registered conveyors and R8 for the State's contribution to the purchase of stock feed.

During the year under review an amount of R223 612 was paid out to ostrich farmers.

Flood damage

The country experienced two floods during 1987 and 1988 and the State introduced special assistance measures to give support to farmers in the flood-stricken areas.

In respect of the flood disaster in Natal during September/October 1987 a further amount of R18 953 357 was paid out during the financial year. 1 571 persons received assistance.

As a result of the flood disaster in February/March 1988 several areas of the Free State, the Northern and Central Cape and the Transvaal and the Magisterial District of Ladysmith, Natal, were declared flood-stricken areas in respect of which R65 647 073 was paid out during the financial year, and 2 665 persons received assistance.

Registration of mortgages and documents of consent and the issuing of deeds of grant

During the year under review 1 321 mortgages were registered, as against 1 999 the previous year. A total of 2 121 documents of consent were registered, compared with the 1 717 of the previous year. Cases in which the Department had to waive priority in favour of the Land and Agricultural Bank of South Africa also decreased to 229, compared with the 423 of the previous year. A total of 65 deeds of grant were registered in respect of State land that was sold.

Legal services and estates

A total of 114 debtors' estates were sequestrated at the initiative of other creditors. In seven cases the Department had to attach properties in order to recoup or partially recoup outstanding mortgage debts, as these persons had given up farming.

Recovery of debts

In the case of stock feed loans, there were numerous requests for extension or consolidation. A lenient policy is followed whereby farmers are given the opportunity to pay back stock feed loans in three equal annual payments.

The total amount owed to the agricultural credit account amounted to about R940 million at the end of the financial year, as against R957 million the previous year.

Control over securities

To safeguard the State's securities, agricultural credit controllers carried out 833 special and 2 095 routine investigations. About 210 attachments were carried out.

Agricultural credit controllers also rendered assistance in recovering debts. By means of personal contact with debtors an amount of R4 002 304 was collected.

AGRICULTURAL ECONOMICS

Production economics research

During the past year various projects were resumed, continued or completed, whereas a few had to be discontinued owing to limited manpower or funds or because of other urgent priorities. A number of new essential projects were also started. The most important activities may be summarised as follows:

Production factor studies - The following investigations were resumed:

- An agricultural economic evaluation of alternative irrigation systems in the Orange-Vaal irrigation area.
- The evaluation of financial aid schemes under the Agricultural Credit Act.

Structure studies - The following investigations were completed:

- Economic analyses in respect of:
  - ORP: Lower Fish River State Water Scheme
  - Douglas
  - Sundays River
- An evaluation of the contribution of irrigation development to regional development.
- The effectiveness of interest subsidies on carry-over debts and new production credit to crop farmers in the North-Western Free State.
- Cost benefit analysis for the provision of irrigation water from the Theewaterskloof Dam in to the Eerste River Valley.

Operating and production cost surveys - Since production costs no longer play a decisive role in the fixing of prices by the Maize and Wheat Boards, it was decided to discontinue regular production cost surveys. However, the Directorate will continue to monitor the economics of maize and wheat production in various other ways from time to time.

Typical farm models for policy research - Work continued on the comprehensive project on the development of methods and computer models regarding typical farming units in different areas in the country with a view to policy and macro-economic research.

The ultimate object of this project is the development of computer models of typical farms for all the important farm types in each broadly homogeneous resource area.

Ad hoc **policy investigations** - The ever-weakening financial position of many farmers has resulted in applications from several farming communities for special State aid. Several *ad hoc* investigations were launched for the consideration of these applications. During the year under review the Directorate was involved in the following investigations of this nature:

- The current economic and financial position of farmers in the Elands River and Sourveld farming area of the Eastern Cape (Humansdorp).
- The economic and financial position of vegetable farmers in the Tala Valley (Pietermaritzburg).
- The economic and financial position of pineapple farmers in the Eastern Cape (East London/Bathurst).

Farm management techniques - During the year under review the development of management aids and information systems received further attention. The maintenance and further expansion of the computerised income and cost estimates system (COMBUD) and the maintenance of norms for implement costs continued, for which the information for 1989 was processed and published. A start was also made on the investigation into the optimum selection of agricultural enterprises in certain identified areas in the Swartland.

Farm business economics with mail-in records as the source data - This service has been provided for more than 20 years. The number of mail-in record collaborators that received analyses of their farms during the year under review increased from 554 to 563 and represented 80 study groups. Only 34 farmers were linked up actively with the computerised Transakplan.

Income and cost estimates - The computerised income and cost estimates system (COMBUD) has grown by 89 estimates to 793. These consist of 695 crop and 99 livestock estimates which are made available individually and in volume form.

Enterprise ratios - In co-operation with researchers in regions and at institutions attention was given to various facets relating to input/output ratios during the year under review. The majority of the investigations deal with stock production systems and the use of feed and pastures under certain circumstances in different areas in the country. Attention was also given to a strategy for production maintenance in and renewal of established citrus and subtropical fruit orchards.

A start was made on the following new projects:

- Development of a veld utilisation system with the elimination of untimely fires for the extensive grassveld grazing in the high rainfall sourveld area in the South-Eastern Transvaal.
- Management of a dairy on a small farming unit utilising cultivated pasture.
- The evaluation of a mixture of irrigated Midmar grass and arrow-leaf clover in terms of slaughter lamb production.

Training and advice

More than 98 lectures and 49 practical classes in agricultural economics were given at the five agricultural colleges. The revision of the agricultural economics lectures presented to juniors at the agricultural colleges continued.

An expanded advisory service is provided in support of the Department's extension service.

SUPPORTING SERVICES

Biometric and datametric services

Biometric services

Biometric services include mainly the following two areas:

- The investigation of field trial data within a multivariable framework. The conventional approach is to analyse measured variables separately and then attempt to find links between them. The multivariable approach allows the simultaneous analysis of a number of variables, with the result that patterns can be observed more clearly.
- The investigation of methods of establishing improved accuracy of field trials before they are carried out and after the data have been collected.

The practical execution of these investigations is established through co-operation with the Fruit and Fruit Technology Research Institute, the Small Grain Centre and the Vegetable and Ornamental Plant Research Institute.

An important matter occurring in all regions/institutes is the involvement of biometricians in the rendering of particulars with regard to statistical analyses and the interpretation of trial results in publications and post-graduate theses.

Because of the great shortage of biometricians work of a biometric nature must often be undertaken by datametric staff. In the Natal Region there is a formal agreement with the University of Natal for consultation services in order to support the biometric staff. During the past year the biometrician of the Winter Rainfall Region has also rendered services to the Eastern Cape Region and the Viticultural and Oenological Research Institute. There is also close co-operation with the Biometric Department of the University of Stellenbosch.

Datametric services

Datametric services include mainly the following activities:

Programme development and maintenance, the design and development of data bases and systems, the purchase or rental of computer packages to meet the needs of the various Departmental bodies and training in and advice on the use of these, the determination of needs in respect of computer facilities and networks and assistance with the installation and maintenance of such facilities and networks.

Programme and system development - A system of interest is the geographical information system in operation in the Winter Rainfall Region. Assistance was also given to the Transvaal Region in the planning, co-ordination and development of a geographical information system.

Datametric staff from the Transvaal Region were also involved in information systems for the research stations at Athole, Mara and Soutpan.

In the Natal Region the development and testing of a financial record-keeping system was completed. Furthermore, a system was introduced to store and process analytic data from laboratory analyses of about 20 000 soil samples on a computer annually with a view to recommendations in respect of fertiliser and lime applications for a specific farm and crop.

Programmes that were developed during the year under review were aimed mainly at local needs in regions and institutes and include:

- crop production advice and a seeding density model for wheat in the Winter Rainfall Region;
- a botanical survey in the South-Eastern Transvaal;
- the reflection of relative radiation on slopes; and
- the identification of crop and veld ecotopes, the storage and the making available of agricultural production information and soil management in the Natal Region.

Data processing and graphics - Statistical analyses and a variety of graphical representations were carried out at the various establishments. With the greater availability of micro-computers and suitable programmes there was a tendency for an increasing number of analyses to be carried out on micro-computers at the cost of main frame use. Many researchers prefer to make analyses themselves and refer to the biometrician or datametrician only in problem cases. Consequently, more attention had to be given to the training of researchers.

During the year assistance was also given in analyses of questionnaires on sheep farming and feed flow systems in the Northern Drakensberg grazing region, with a requirement determination of woolled sheep extension and field services and with regard to the value of agricultural college training.

In-service training

Several seminars and short courses were held in order to train the staff, and particularly researchers, in the use and interpretation of standard and newer biometric techniques. In-service training in respect of datametric services includes the training of datametric staff and also the training of researchers in the use of computers.

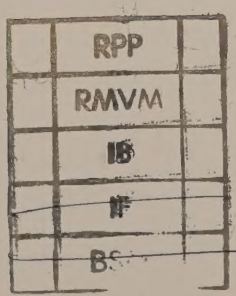
Research by other institutions

Contract research at universities

There were 104 applications to undertake research at universities, 64 of which concerned continuation of existing research and 40 new applications. Seventy-two of these were granted. The universities of the Orange Free State, Witwatersrand, Pretoria, Natal, Stellenbosch, Cape Town, Fort Hare, Western Cape, Rhodes, Potchefstroom for CHO, Rand Afrikaans University and the Medical University of Southern Africa were involved.

Ad hoc research at universities

One application for *ad hoc* research was received and approved, and R58 250 was allocated for the project.


RPP
RMVM